PROCEEDINGS

of the

93rd Annual Conference

of the

American Railway
Bridge & Building Association

1988

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Proceedings of the

Ninety-Third Annual Conference

of the

American Railway
Bridge & Building
Association

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TABLE OF CONTENTS

Page
Index to Advertisers 3
Officers for 1988 6
Officers for 1989 7
Session—September 19, 1988 9
September 20, 1988 63
September 21, 1988 121
Secretary's Report 106
Treasurer's Report 106
Audit Committee Report 107
Necrology Report 108
Report of Resolution Committee 154
Joint Installation of Officers 155
Historical 159
Constitution 164
By-Laws 168
Bibliography of Contents 218

ADDRESSES AND COMMITTEE REPORTS

Address —
Harry J. Bruce, Chief Executive Officer, Illinois Central Railroad 12
Development of High Speed Mitre Rails for Amtrak's Moveable Spans —
A. E. Shaw, Amtrak 16
Clearance Measurement —
Lars Lundberg, SRS-America 22
Tunnel Enlargements on UP —
J. R. Beran, Union Pacific Railroad 25
Are Changes in Rail Labor/Management Relations Keeping Pace with Changes in the Rail/Truck Competitive Environment —
Dr. Benjamin J. Allen, Iowa State University 34
Committee Report —
Masonry Repairs to Buildings and Shops
J. H. Smith, IC, Chairman 41
Jacking Large Concrete Boxes under Railroad Tracks —
A. Lynn, Quikbridge 47
NJ Transit Meadows Shop —
J. M. Weber, NJTRO 51
Committee Report —
Concrete Backwall and Seat Repairs
M. L. Bradley, Conrail, Chairman 55
Address —
J. A. Zito, Senior Vice President Operations,
Chicago and North Western Transportation 64
Panel Discussion —
Spent Cross Ties Disposition 70

Maintenance and Safe Use of Gas Welding Equipment—
Ben F. Jezek, Victor Equipment Company 78
Committee Report —
Performance of Precast Concrete Ballast Deck Slabs
T. V. Dunn, C&NW 85
Fire Safety
Roger Fitch, Union Pacific 92
Committee Report —
Repair and Maintenance of Counterweight Systems
J. A. Lileikis, UP, Chairman 98
Standing Committee — Training 114
Standing Committee — Equipment 115
Standing Committee — Material
Timeliness of Steel Deliveries
Sid Blaauw, Paxton Vierling Steel 109
Inspection Vehicles
Lars Lundberg, SRS-America and John W. Stubenvoll, Reach-All 116
Film —
Construction of TGV Atlantique by SNCF 121
C&NW Diesel Shop at Proviso Yard
P. H. Saletnik, C&NW 122
Roller Compacted Concrete
Brian T. Bock 134
Vegetation Management
T. F. Sheahan, CSX 139
Peacekeeper Rail Garrison Project
Capt. K. Creighton, USAF 141

INDEX TO ADVERTISERS

Page
Alert Mfg. 171
Altair 213
Arcair 173
Alfred Benesch 213
Berkel & Co. 171
BKBM Engineers 213
The Wm. Brode Co. 175
Carlisle SynTec Systems 177
Commercial Light Co. 179
Conley Frog & Switch 181
Corcon 175
Cowin & Co. 214
DB Industries 169
Detzel Construction 183
DuPont 185
Envirodyne Engineers 214
Esca Consultants 214

Fairmont RY Motors 187
Foundation Equipment Corp. 183
Goex Inc. 189
Hardesty & Hanover 215
Hazelet + Erdal 215
HDR Engineering 215
Huck Mfg. 191
Hydro Conduit 216
Intrusion Prepakt 193
Kershaw Mfg. 195
F. K. Ketler 216
Loram 197
Meany Electrical Engr. 191
R.T. Milord Co. 199
Modjeski & Masters 216
Osmose 201
Pileco 202
Power Parts 203
Racine 204
Railquip 201
Rails Co. 205
Shannon & Wilson 217
Sheets Masonary 206
Shugart 207 & Inside Back Cover
SpanDeck 208
Speno 209
Spider Staging 210
Spray Foam 211
SSI Mobley Inside Front Cover
Wadsworth 210
Western-Cullen-Hayes 212
Ralph Whitehead 217

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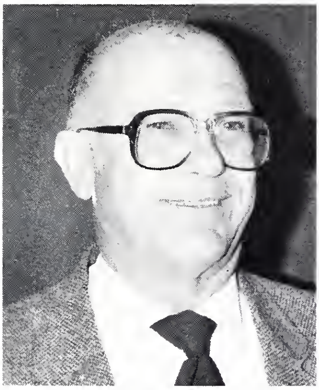

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PROCEEDINGS

OPENING JOINT SESSION

Monday, September 19, 1988

The first joint session of the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America was called to order at the Palmer House, on Monday, September 19, 1988, Mr. Donald J. Lewis, President of the American Railway Bridge and Building Association, presiding.

President Lewis: As President of the American Railway Bridge and Building Association and on behalf of Mr. Raymond E. Snyder, President of the Roadmasters and Maintenance of Way Association of America, I declare this, the 93rd Annual Conference of the American Railway Bridge and Building Association and the 100th Annual Conference of the Roadmasters and Maintenance of Way Association of America, to be open and in joint session. It is proper that we pause to ask for divine guidance and inspiration prior to commencing this conference. I would like to call upon John J. Horney, our junior vice president from the Union Pacific Railroad, who will deliver the invocation. Mr. Horney.

Mr. Horney: Will you please stand with me while I pray. Our heavenly Father, we stand before you at this time, first to thank you for providing a safe trip for those of us who have traveled to this conference. We ask, Father, that you be with the speakers who will be with us at the conference today, to give them encouragement and guidance during their presentations. We have come here to this conference to learn, and we ask, Father, that you provide an atmosphere of sharing during this conference so that all of us may learn from our peers. And, finally, we ask that during the close of the conference, that you once again, provide safe travel for us on our return trips home. We ask these things in Jesus' name. Amen.

President Lewis: Thank you, John. Some of you may not know that John is recovering from a near fatal accident a few months ago. He fell approximately 40 feet and seriously injured his lungs, fractured some ribs, and had a serious hip problem. We are all happy to see you recovering so quickly, John. I am sure that it is your own positive attitude toward life that is aiding your recovery.

I join with Mr. Snyder in welcoming you to the first joint session of the two associations at this year's annual conference. As you may know, there is also the annual convention of the Railway Supply Association featuring RSA Rail Expo '88 which is in conjunction with the annual meetings of the coordinated mechanical associations. Their meeting is normally a week apart from ours, but this year it happened to fall on the same date. If, by chance you are in Chicago for that meeting, it is being held at the Chicago Hilton and Towers.

Now, back to our conference. As you can see in the program, we have presentations covering many different topics related to railroad engineering and construction. We do have a change for the Wednesday, 9:25 a.m., special feature. Mr. Juenette was unable to attend, and in his place we will have Mr. Brian T. Bock of the Portland Cement Association explaining the use of roller compacted concrete.

For several years we have indicated "get involved", and it is through your involvement and participation that information is disseminated to others. Every day we are exposed to something new, and this is how we learn.

For the ladies, there is a bus transporting them to a wholesale shopping mall in one of our western suburbs today where they will be free to browse. Tomorrow, there will be a trip to the Museum of Science and Industry, including the Henry Crown Space Center, with lunch at a restaurant called "Charlie Club". The ladies will then have the option of a presentation at the Art Institute or of returning to the hotel.

I would like to introduce the officers and directors of the American Railway Bridge and Building Association who are seated at the head table. As I introduce each person, I ask that he stand and remain standing until all have been introduced.

Beginning on my left, Senior Vice President R. A. Tallent, Jr., process engineer structures, Norfolk Southern Corporation; Junior Vice President B. T. Burns, assistant manager structures, Atchison, Topeka and Santa Fe Railway; immediate Past President, J. T. Kapp, project manager construction design and construction, Conrail; Treasurer, J. M. Williams, retired supervisor B&B, Elgin, Joliet and Eastern Railway; Director M. C. Walbrun, manager engineering design, Amtrak; Junior Vice President J. J. Horney, program engineer B&B, Union Pacific.

Beginning with the directors on the bottom row, D. L. Steele, manager structural scheduling, Union Pacific; C. E. Thompson, B&B master, Canadian Pacific; R. C. Karsten, general foreman B&B utilities, St. Louis Southwestern; J. A. VanHuis, chief engineer structures, Wisconsin Central; S. Lipkus, bridge and structures maintenance engineer, Canadian National; W. H. Nelson, manager maintenance of way training, Burlington Northern; T. J. Parker, project manager, Envirodyne Engineers; H. L. Davidson, engineer B&B, CSX Transportation. (Applause) Now I will turn the rostrum over to Mr. Ray Snyder, President of the Roadmasters and Maintenance of Way Association of America. Mr. Snyder.

President Snyder: Thank you, Don. I would like to join with Don, on behalf of the Roadmasters' Board, to welcome you to our conference. I am sure that you all will find these presentations very informative and thought-provoking. At this time I would like to introduce the Roadmasters' Board. As I introduce each person I ask that he stand and remain standing until all have been introduced. Please hold your applause until all have been introduced.

First Vice President, Al Matte, supervisor maintenance of way, Canadian Pacific; Second Vice President, Keith Pottorff, assistant general manager maintenance, Atchison, Topeka and Santa Fe Railway; immediate Past President, Mike Marlow, senior project engineer, tracks and property, Elgin, Joliet and Eastern Railway; Treasurer, Jerry Cossel, chief engineer, design and construction, Conrail; Director Hugh Fuller, engineer of administration, CSX Transportation; Director Steve Hill, assistant regional engineer, Soo Line.

Beginning with the Directors on the second level, Sam Brunner, construction engineer, Illinois Central Railroad; McKinley Scott, director track maintenance Northeast Corridor, Amtrak; Gene Schubel, roadmaster, Burlington Northern; Johnny Johnson, manager maintenance of way training, Atchison, Topeka and Santa Fe Railway; Ken Koff, supervisor of track, Chicago, Missouri and Western; Keith Nordlund, project manager, Canadian National; Al Butler, chief regional engineer; Conrail; Carl Edwards, roadmaster, CSX Transportation. (Applause)

Now I would like to introduce Mr. Stan McLaughlin, assistant vice president engineering, Union Pacific Railroad, and President of the American Railway Engineering Association. Stan.

Greetings from AREA

Mr. McLaughlin: Thank you, Presidents Lewis and Snyder. The American Railway Engineering Association has enjoyed a long and happy relationship with the Roadmasters and Maintenance of Way Association of America and the American Railway Bridge and Building Association. These three professional organizations have been very supportive of each other in the past and I know that we will continue to have a close working relationship in the future.

The presidents and vice presidents of our three organizations met last fall to discuss our respective roles and interrelationships. As a result of this meeting we agreed on three important principals. One, each of our organizations, the AREA, Roadmasters Association and the B&B Association, have a distinctly different and important role to play in the railroad engineering community. We unanimously agreed that all three organizations have a bright future and should continue to exist separately. Two, we also agreed that it is equally important to continue coordinating our activities so that we are not wasting time and resources. In other words, we want to be sure that we aren't doubling the hill. Since almost all work accomplished by each organization is done voluntarily by our committee members we can ill afford to waste precious time. Consequently, we agreed to establish a small coordinating committee made up of a couple of directors of our respective organizations to meet once or twice a year to make sure that our work complements each other and to ensure that we are coordinating our activities to the extent desirable.

Three, we agreed that REMSA is an equally important member of our technical community, and that we want to continue our long and prosperous relationship with the Railway Engineering Maintenance Suppliers Association. We know that we need REMSA, and REMSA needs us more than ever if we are to be successful in the years ahead.

I am pleased and honored to participate in the opening session of the 1988 B&B and Roadmasters conference. On behalf of the AREA, I want to thank Presidents Lewis and Snyder for including us in your program. The agenda of technical presentations and panel discussions that you have planned for the next three days should prove to be extremely interesting and worthwhile. I wish you the best for an enjoyable and productive conference.

Finally, I would once again like to thank REMSA for their continued support of our three organizations. Without your participation I doubt that these technical conferences would be nearly as successful as they have been and will be in the future. I look forward to seeing many of you at the AREA regional meeting in Guadalajara next month, at the AREA technical conference in Chicago next March, and at the REMSA equipment show held in conjunction with your annual technical conference in Toronto next August. Thank you. (Applause)

President Lewis: I would now like to introduce Mr. Avon Lane, sales manager of Fairmont Railway Motors and President of the Railway Engineering Maintenance Suppliers Association. Mr. Lane.

Greetings From REMSA

Mr. Lane: President Lewis, President Snyder, special guests, ladies and gentlemen. Thank you, Stan, for your kind words concerning REMSA. We really appreciate that. As President of REMSA, I am honored to have been asked to join in welcoming the annual conference of the B&B and the Roadmasters Associations. I know that all members of REMSA join me in wishing you a most productive conference over these next three days. We also hope that your stay will be a pleasant one, and if the officers and directors of REMSA can be of assistance in any way, please let us know.

I wish to take this opportunity to invite all of you and your spouses to the annual REMSA reception tomorrow evening in the Grand Ballroom. There will be refreshments, hors d'oeuvres, and music. Complimentary tickets for registered railroad personnel and their spouses are available at the REMSA table in the registration area both today and tomorrow. The 6:30 to 8:00 p.m. hours for this reception will hopefully permit everyone to attend and still be able to keep a late dinner date and to visit with the REMSA member hospitality suites. Thank you very much. (Applause)

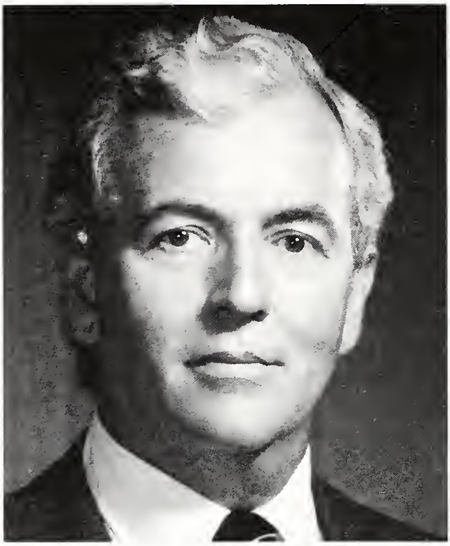
President Lewis: Thank you, Avon. At this time it is my privilege to introduce our keynote speaker for this opening session. Mr. Harry J. Bruce is chairman and chief executive officer of the Illinois Central Railroad. He received his Bachelor of Science degree from Kent State University, a Master of Science degree in Transportation Economics from the University of Tennessee, and is a graduate of the Advanced Management Program at Harvard Business School. He has extensive business experience in the logistics field, particularly the railroad industry. He is author of several articles and two books, ''Distribution and Transportation Handbook'' and ''How to Apply Statistics to Physical Distribution''. He authored the chapter ''Physical Distribution'' in the 1986 edition of the ''Handbook of Modern Marketing''. Mr. Bruce is a Trustee of the Glenwood School for Boys; member of the advisory boards of Northwestern University and University of Tennessee; and council member of the International Executive Service Corps. May I present Mr. Harry J. Bruce.

KEYNOTE ADDRESS

The Illinois Central Railroad: How We Built Our Bridge to the 21st Century

Harry J. Bruce

Chairman and Chief Executive Officer
Illinois Central Railroad



Harry J. Bruce

Good morning, and thank you for inviting me to open the 93rd annual conference of the American Railway Bridge and Building Association and the 100th conference of the Roadmasters and Maintenance of Way Association of America. Your organization is a proud one, and with good reason: your craft is ancient, and remains as important today as when man first threw a log across a stream.

That is one of the first lessons I had to learn when I was named chairman of the Illinois Central Railroad five years ago.

To the best of my recollection, it all started about two weeks after I took office in September, 1983. Our chief engineer of bridges at that time, Dan Beckley, took me out on an inspection trip. At least that is what he called it. In fact, our inspection was so thorough and rigorous it might as well have been called Railroad Bridge Building and Maintenance 101. Dan subjected me to total immersion, and it really opened my eyes to the accomplishments of your profession.

The climax of the trip came when Dan and I walked all 4,224 feet of the imposing high bridge that the Illinois Central erected in 1935 over the Ohio River at Cairo, Illinois. Dan lectured me on all the fine points, using the bridge itself as a visual aid, and by the time it was over, I was well on my way to being a bridge junkie. I became haunted by the mysteries of bridge engineering and design. When my friend, Bob Schwarz, vice president of Boise-Cascade, sensed my growing fascination, he gave me his copy of the 1941 edition of Shedd and Vawter's "Theory of Simple Structures". Bob told me he had had the volume ever since he first studied engineering as a cadet at West Point.

I still keep my Shedd and Vawter on my nightstand for bedtime reading, and it has helped me develop a keen admiration for the accomplishments of the bridge builder.

It has also made me aware of the remarkable symbolic power that bridge building has on the way we communicate. Our language is full of metaphors that use bridges to dramatize certain recurring and meaningful human situations.

Lawyers and negotiators talk of "bridging the gap" between two contending factions. Diplomats talk of "building bridges of understanding" between hostile nations. When fear or confusion force us to postpone a difficult decision we say, "We'll cross that bridge when we come to it." When we have finally made our decision—and made it irrevocable—we say, "We have burned our bridges behind us". When some power—human or spiritual—helps us through a difficult time we call our helper "a bridge over troubled waters". People use bridges as metaphors to help them grapple with painful or difficult experiences—particularly transitions.

But have you noticed something? People also use bridges as a metaphor for hope. The image of a bridge expresses our beliefs that we can leap across the space that separates us from our goals and resume our progress forward.

That is exactly how I want to talk about what we are doing at the Illinois Central Railroad. We have spent most of the past decade, and virtually all of the five years since I was named chairman, in building a bridge that would carry us safely from the past into the future. We have had to design and build a structure that would carry us from the safe, comfortable and disappearing world of regulated monopoly into the very real world of deregulated, highly competitive transportation companies.

In between those two shores lies a gap of uncertainty, insecurity, and anxiety. To cross that gap and carry us to the safety of the far shore, we have had to build a new kind of railroad company. Here is how we at the Illinois Central built our ''bridge to the future''.

Like any real bridge, a corporate bridge from the past to the future must have sound supports. We have two of them, and like a pair of piers that go down to bedrock, they hold up everything else.

The first pier is our philosophy that the new Illinois Central must be as different as possible from the regulated, monopolistic railroads of the past. Unlike its predecessors, the new Illinois Central has been designed to be driven by customer demand exercised through classic free-market mechanisms. What we do is determined solely by what shippers want and what they are willing to pay; not by government allocation.

A philosophical commitment to free-market railroading would be insufficient, however, without the financial strength to make it a reality. So our second supporting pier, if you will, has been the willingness of our strong parent company, IC Industries, to invest in the railroad's future and prepare our company for its eventual independent existence.

IC Industries, by the way, is building a bridge of its own to carry it from its past as a heavy-industrial company to its future as a consumer-products company. As part of that bridge-building process, the railroad is being ''dividended'' to IC Industries' shareholders as an independent entity. We expect the Interstate Commerce Commission to give us the green light shortly.

Upon these two piers—a clear, realistic sense of mission and a sound financial foundation—we have proceeded to design the superstructure of our bridge to the future.

That design has had one simple theme: efficiency. Like a real-life bridge, the new railroad had to be designed to carry the anticipated loads.

So when I became chairman in 1983, I put together something like a B&B gang, a special team of individuals assigned to determine just what size, shape, configuration, and strengths our new company had to have. The only difference between our corporate headquarters and an engineering shop was that our gang was made up of planners, financial analysts, and business and market forecasters.

Together, our gang designed computer models of the railroad we needed. Like bridge engineers, they performed stress testing on these models to find out where and when they would ''break'' under different scenarios.

What our gang reported was something many of us had long suspected but had never before been able to document accurately. We were too big and ran in too many directions to be efficient and profitable. It was not a particularly safe or efficient structure to carry us forward.

The original Illinois Central chartered in 1851 by the State of Illinois envisioned a simple north-south main line fed by a few branches, all of it designed to gather midwestern crops and minerals and funnel them down to New Orleans.

But over the course of more than a century this simple scheme had been compromised by a series of acquisitions that collectively never lived up to their promise.

By 1972 our map was a meaningless tangle of redundant routes that went everywhere and nowhere. Between Memphis and New Orleans alone we had four different routes, none of which we could afford to maintain adequately.

In addition, we had a 500 mile east-west line from Chicago that reached the Missouri River at both Omaha and Sioux City; a 400 mile east-west component from Meridian, Mississippi, to Shreveport, Louisiana; and a 600 mile line from Chicago to St. Louis and Kansas City.

These east-west lines were particularly probemtical. By the early 1980s the mega-merger movement had created three extremely efficient east-west carriers east of the Mississippi and three others west of the river. Those new super-railroads had no need for single-track, unsignalled "bridge" railroads of the type we were operating, and under deregulation they no longer were obligated to share any business with us.

We really got our eyes opened when we reviewed our last three decades of tonnage diagrams. They showed that while our branch lines and east-west secondary mains had steadily been losing traffic, our historic north-south core railroad was holding its tonnage levels well and could carry that business quite profitably if the expensive, non-producing parts of the railroad could be eliminated.

In fact, we realized that if we could focus on the core railroad, a system numbering about 2,800 miles, we would not have to be satisfied with its existing tonnage. We could actually cultivate and develop new business, something that is hard to do when you are constantly putting out fires on a money-losing 10,000 mile system, which is what we were in 1972. That's right: we had as much track as the old New York Central and as many employees as the Santa Fe, about 21,000, but with nowhere near the traffic or efficiencies of either.

Historically, the railroad industry has had a program for eliminating money-losing lines. It abandoned them. And we did some of that. By the time I became chairman we had abandoned 2,600 miles.

But our B&B team had a better idea. We noticed that some of the abandoned Conrail lines out in the East had been purchased by entrepreneurs who were operating successfully with two-man crews and rational work rules not available to unionized Class I carriers.

So instead of abandoning our surplus lines, we put them up for sale in the most carefully planned and executed marketing campaign ever seen in the railroad industry. The aim was not simply to dispose of route miles, but to sell our lines in discrete segments, each of which made sense as an independent company.

Well before the line sales were announced, our team studied each surplus line segment to determine what particular stretches had the best potential to function as free-standing corporate entities. Each future railroad property got its own working title. We called them "Newco I", "Newco II", and so on, and for each one we created a catalog showing all the features each buyer would get; so many miles of track, so many miles of double track or sidings, so many signals, bridges, buildings, yards, shops, locomotives, and so forth.

We worked out a price for each property, and then, just like bridge engineers, we added a "safety factor" to each price. After all, like bridge engineers, we knew we could not possibly be aware of all the factors that should have entered into our calculations. So we adjusted our original estimate to compensate for any possible contingencies.

In 1985 we began selling our properties. The results have been beneficial to all concerned. Most of the entrepreneurs have been able to make money with lines that were unprofitable under Class I ownership. The shippers continue to receive service they otherwise would have lost, and most are receiving improved service. The employees have retained their jobs, and on some properties, furloughed employees have been rehired. On-line communities retain a transportation resource that strengthens their potential for economic development. They also benefit from property-tax payments that would have dried up had the Illinois Central abandoned the lines.

For us at the Illinois Central, the line sales have produced three powerful benefits. First, by eliminating unprofitable route segments, we have reduced our expenses drastically. Second, because we sold rather than abandoned lines, we raised valuable cash that we have plowed back into the rehabilitation of our core railroad. Third, because most of the line segments feed part of their traffic to us, we continue to earn revenue on that segment of the haul that is performed on our remaining railroad. Shedding lines does not necessarily mean that we shed business. It means that we shed the unprofitable part of it.

As we downsized our railroad, we also downsized our staff. In 1983 we had 11,500 people on our payroll. Today we carry 4,500, of whom only 475 are managers. In fact, management took the bigger hit, an 85 percent reduction in ranks versus a 70 percent drop in scheduled employees.

The positive effects of our downsizing are evident in every set of numbers cranked out by our financial department. In 1983 our operating ratio was slightly more than 99. We were barely a break-even railroad. Today, it is just under 90 percent, right in the middle of the Class I railroads. In 1983 we hauled 160 loads per route mile. This year we will haul 310. That figure reflects dramatically what one can do when low-density appendages of a railroad are placed in the hands of low-cost operators. In 1983 we hauled 100 carloads per employee. This year we will haul 190. As for operating income per employee, in 1983 that figure was $700. This year it will be $12,700. That is up by a factor of 18!

All these improvements in performance have come while our annual carloadings fell from 1,150,000 in 1983 to an estimated 870,000 in 1988. We are hauling less now, but we are enjoying it more.

As exciting as these financial figures are, however, I think that for those of you in the engineering profession the real excitement and the real proof of our corporate transformation is out there on the property.

If you could join me on an inspection tour of the Illinois Central today, you would observe that transformation in stone and steel. As vice president engineering and mechanical, Charlie Davis, will confirm, we have absolutely no deferred maintenance on our railroad. In the last ten years we have spent $1.5 billion on restoration and maintenance of the right-of-way. Sixty percent of our main line trackage is now continuous welded rail, and it is heavy stuff, up in the 132 and 136 pound categories. The ballast is high, and the ditches are deep. If the dispatcher issues a slow order it is because there is a tie gang or a bridge gang at work.

Our bridge gangs, by the way, are very busy these days, replacing those hundreds and hundreds of timber trestles for which our lines in the Mississippi Delta and the Louisiana bayous have been famous. Slowly but surely they are all being converted to steel and concrete. Bridges, in fact, are a major part of our bridge to the future.

A moment ago I gave you a peek at some impressive new figures from the financial department. Let me close with some numbers I think are even more impressive. They come from the operating department and the engineering department.

As recently as three years ago, the Illinois Central's annual derailment bill, and I am confining this to property damage alone, was $20 million. Last year it was down to $7 million. So far this year it is $750,000. And since July 1 we have had no derailments at all.

One reason is that on that date I issued an executive order that employees are to report any track defect they encounter, and that repairs are to be carried out immediately. Simply issuing a slow order is not enough any more. The bitter experiences of the 1970s taught us a valuable lesson. The money allegedly "saved" by deferred maintenance is soon wasted many times over in the immediate damage and ongoing loss of business caused by derailments.

At the Illinois Central Railroad we have stricken the term "deferred maintenance" from our lexicon. It is considered bad manners to use that kind of language around our company. We think we have discovered a better way to talk. We say, "Fix it up before you have to pick it up."

With the promulgation of our no-derailment policy, we have essentially completed construction of the Illinois Central's bridge to the future. Our railroad now is sized and configured correctly to handle the business our planners have identified as its market niche. It has been physically rebuilt to do that work at the highest levels of service in its history. It has been financed soundly by its parent company, so it can leave home and seek its fortune independently. And it has been staffed with the right people, in the right numbers, in the right places to do its work and grow.

Yes, we have finished rebuilding our bridge to the future, but our work is hardly over. After all, once you cross the bridge, you still have to climb out of the valley. I assure you that the 4,500 people who make up the Illinois Central are looking forward to that trip. Thank you. (Applause)

President Lewis: Thank you, Mr. Bruce, for a very enlightening address. We appreciate your taking the time from your very busy schedule to come and speak before our membership.

At this time I will turn the program over to Mr. Byron Burns who will introduce our first special feature speaker. Byron.

Mr. Burns: Thank you, President Lewis. Our next speaker is Mr. Al Shaw, Jr., of Amtrak. Mr. Shaw started his railroad career in

1954 with the Pennsylvania Railroad and has held numerous positions with the Pennsylvania and the subsequent companies of Penn Central and Conrail, including supervisor of track, assistant engineer tests, superintendent maintenance of way equipment, regional staff engineer, and superintendent welding plants. In 1976 Mr. Shaw joined the Central Vermont Railway as chief engineer, and in 1977 he came to Amtrak. He has since held several positions and is currently the director engineering track and structures. Mr. Shaw is a member of AREA Committee 4 and past chairman of AREA Committee 22. He is also a member of the Transportation Research Board and the Roadmasters and Maintenance of Way Association of America. He is a graduate of Iowa State University and a licensed professional engineer in Pennsylvania and New York. Mr. Shaw's presentation will discuss Amtrak's approach to the problem of mitre rails on moveable bridges. Mr. Shaw.

DEVELOPMENT OF HIGH SPEED MITRE RAILS FOR AMTRAK MOVEABLE BRIDGES

A. E. Shaw, Jr.

Director Engineering Track and Structures
Amtrak

I welcome the opportunity to be able to share our experiences with you on mitre rails, a very important but often neglected part of special track work.

Before I get into my talk, I would like to define what we at Amtrak call a mitre rail.

On moveable bridges it is necessary to break the track conveniently so that the bridge can be opened for water traffic. Each rail of the track is cut on an angle and mitred to make a neat overlapping fit of the ends. The rails fit in a special shoe and are locked in place so that it is known to be safe to operate trains. Simply this is what we call a mitre rail.

Amtrak presently owns or maintains 22 moveable bridges, which have varying track speeds from five miles per hour to 90 miles per hour. Variance in speeds is because of track civil restrictions, bridge conditions, or mitre rail design. Ten of these bridges are on the Northeast Corridor between Washington and Boston.

Mitre Rail Problems

At the beginning of the Northeast Corridor improvement project in 1976, it was recognized that the mitre rails on these structures were not satisfactory to handle high-speed trains for which the corridor was being rehabilitated.

There were several types because of different design theories at the time they were installed by their former owners. None of them had any guard rail protection which, in the event of a broken rail, would keep car trucks aligned properly. Most of them did not have adequate expansion and contraction capability, so the local people had what they called "winter rails" and "summer rails"; short for summer and long for winter. These were expensive to change for the proper season and sometimes the wrong rail was in the bridge at the wrong time. All had poor ties under them, even though many were of recent vintage.

Amtrak's traffic is unique in the industry, in that we have three types of trains. One is freight, which is the standard freight train that all of you are so used to, 263,000 pound cars with the engines necessary to haul the train; two, the standard passenger train, which is one or more locomotives with varying number of coaches; and three, MU's, which is an abbreviation for multiple unit cars, each being self-propelled. The train is made up of varying number of cars.

Basic Requirements

To satisfy the needs of the corridor, our proposed design was to incorporate the following:

1. Utilize an existing off-the-shelf product.
2. Guard rail to be incorporated into the mitre rail.
3. Design adequate for high-speed: 125 miles per hour passenger; 50 for freight.
4. Long life of material with low maintenance.
5. Adequate support system to provide long life with low maintenance.
6. Design to allow adequate expansion and contraction to compensate for thermal dimensional changes.
7. Interchangeability within each type of bridge.

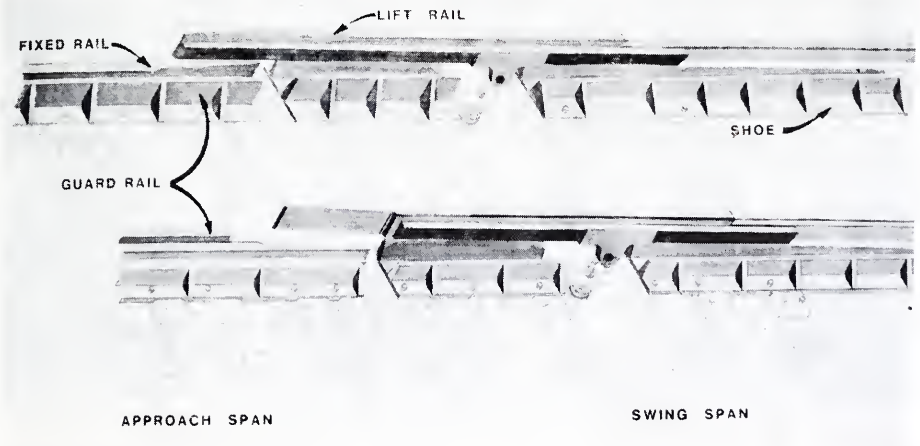
We visited various U. S. railroads which had different types of mitre rails to see which might be the most suitable for our applications, as we did not wish to reinvent the wheel. Unfortunately, we were unable to find a truly compatible situation suited to our needs as all of the railroads visited had restrictions on their bridges, limited the speed, or were all freight, and not really interested in the same criteria we were. We did see mitre rails of an individual railroad's own design but not satisfactory; those which were of good design, but no longer made; and one which was being used at a number of locations and is still manufactured. In addition to seeing what was out in the real world on other U. S. railroads, we contacted the Europeans and Japanese and found out that they do not use moveable bridges on their high-speed passenger lines.

On the Northeast Corridor, Amtrak has three different types of moveable bridges, bascule, swing, and lift. As the only lift bridge in the territory where the speed is restricted, the existing mitre rails, while not as good a design as we might like, were left alone for the time being. A generic specification was written to cover mitre rails for bascule bridges. This specification was to approximate the one that was seen at several locations on other railroads but with more improvements.

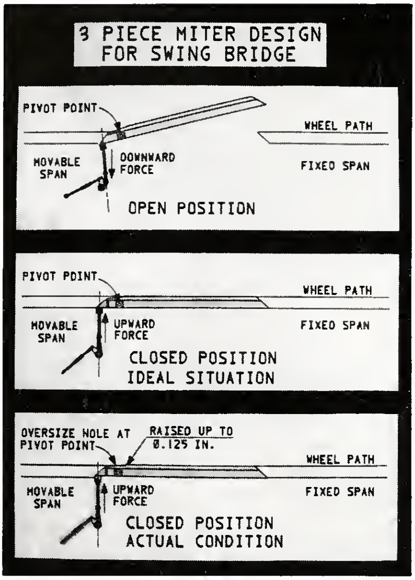
Only one manufacturer bid on the design, and as a result several sets of bascule bridge mitre rails were purchased from this manufacturer. These were installed on several bridges between 1980 and 1982. The bascule bridge mitre rails are two piece and have no independent moving parts. Other than manufacturing and quality control problems, which were corrected, they are continuing to perform satisfactorily.

Ties for Mitre Rails

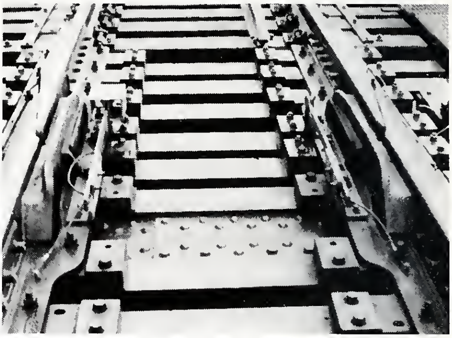
Earlier in my talk, I mentioned that most of the mitre rails on the Northeast Corridor as well as ones seen on other railroads had generally poor tie conditions, not necessarily because of age, but because of the extreme batter that the ties were subjected to with passing traffic. With this in mind, we felt it was necessary to have something better than the conventional hardwood tie under the mitre rail. Therefore, we developed a performance specification for steel ties to be fabricated and placed under the mitre



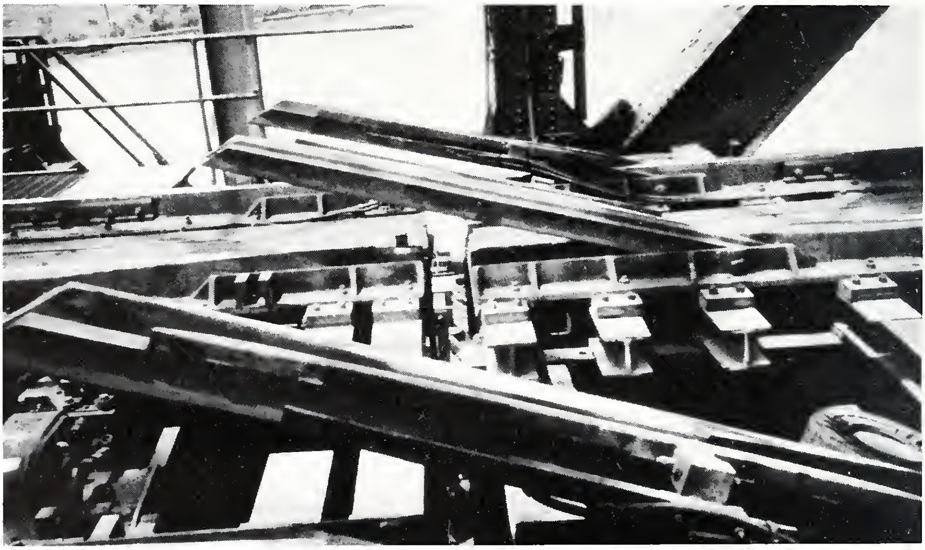
New style Amtrak mitre rail swing bridge.



Mechanism to operate three piece mitre swing bridge.



New style standard bascule mitre rail.



Three piece mitre swing bridge.

rails at approximately the same location as the former wood ties. Due to the shallow depth, it was not possible to use a standard wide flange beam, so a special heavy webbed wide flange beam tie had to be fabricated. On the top of this steel tie was placed an elastomer pad which is a sandwich with steel, rubber, and steel all bonded together with the mitre rail set upon the top of the pad. The elastomer was designed with a spring rate approximating that of an oak tie. The fabricated steel ties had some manufacturing problems, but those were corrected and the pads have performed well.

Mitre Rail for Swing Bridges

Mitre rails for swing bridges are more complicated, because when the bridge turns there must be adequate clearance for the mitre rail on the moveable part of the bridge to clear the fixed part of it.

Based on earlier field trips, we selected a three-piece design which had a moving center part about eight feet long. Connections and operating mechanisms for this moveable piece were designed by other than the mitre rail manufacturer.

Three sets of this design were purchased and placed on three double track swing bridges, where we had proposed speeds of up to 100 miles per hour.

Within a short time after installation, we realized this three-piece design was not satisfactory for our traffic. One bridge has over 200 trains a day crossing it, and many problems developed. The eight foot long moveable part has a mitre at each end which, coincidentally, is about the same length as the wheel base of passenger trucks. This created extreme wear and batter on both of the mitre joints.

The hinge point was not made accurately, which allowed a lot of play in the assembly when it was in position for rail traffic. The running surface of the complete assembly was erratic, and with the high-speed trains, batter at each mitre joint became excessive shortly after installation.

The design of the three piece mitre was more or less a carryover from that which was used on wood ties. The bottom side was not machined, so it was not very smooth nor parallel to the top surface which created additional problems when it was mounted on the elastomer pads on steel ties, because they did not "wear in" and seat like a wood tie would.

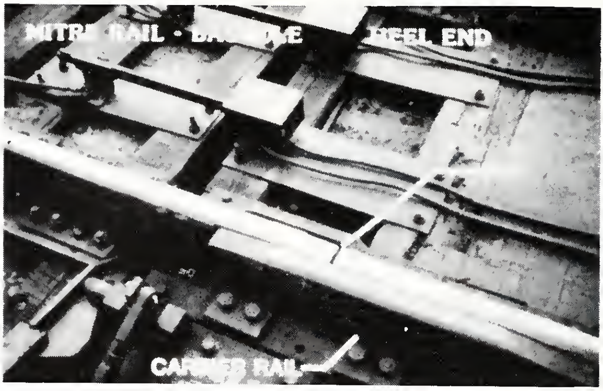
Lastly, the operating device, which raised the center portion, was not designed well.

Signal connections began to break off because of the impact and batter with delays to trains occurring all too frequently. In addition, we were concerned that damage to the bridge substructure and superstructure would occur. We, therefore, placed a slow order on the one bridge that had the most traffic. At first we were concerned the steel ties and elastomer pads were imparting undue shock to the bridge structure, so we made vibration measurements to compare the difference between wood ties and steel ones and found out, fortunately, the steel ones with pads had similar characteristics to the wood ties. Next, we remachined and carefully ground the running surface of each mitre rail which helped, but did nothing to correct the basic problem of the short moveable part of the three-piece design.

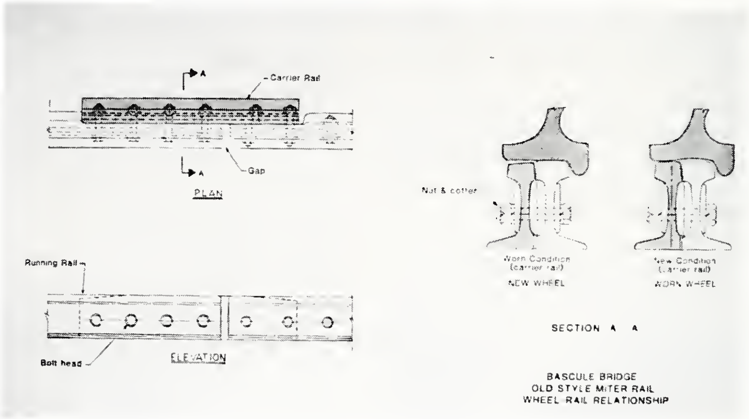
One old design, while it had many drawbacks, no guard rail, no hold-down devices, had one advantage in that it only had one mitre joint for the wheel to cross.

Recognizing the benefits of the new design and the old design, the mitre rail was redesigned. We have incorporated the good features of both types and feel that this should go a long way toward solving the problems we have had.

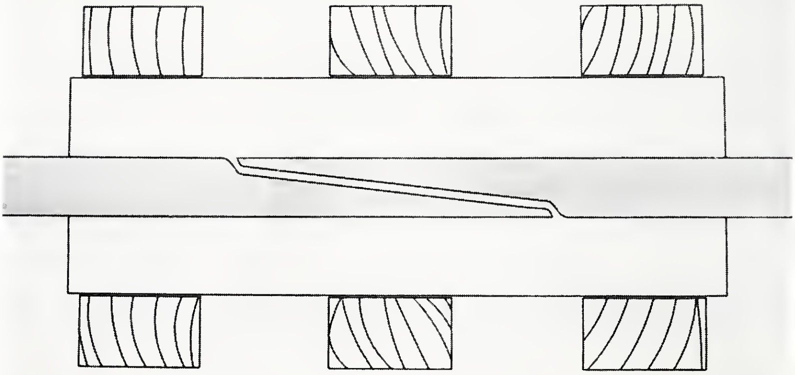
One of the features is the tip of the mitre joint is being manufactured from manganese steel, not the cast variety that most of you are familiar with, but a rolled manganese steel. The chemical composition of the material is the same as the cast manganese. The manganese steel will be explosive hardened to AREA specifications and is fully machined, including the fishing surfaces joining it to the adjacent rail. This will have a glued joint, due to the inability to weld manganese to carbon steel readily. The rest of the mitre joint is all fabricated design, using standard structural steel material. The bolts holding the mitre rail to the steel ties will be A325 structural bolts utilizing self-locking nuts on disk-lock washers which have been used on present installations very satisfactorily. The mechanism for holding the mitre rail down has been completely redesigned from the original type which pushed up rather than pulled down. A downward force of about 2,000 pounds will be applied to the coil springs, which will give the mitre rail resiliency.



Old style bascule mitre rail.



Old style bascule mitre rail.



Amtrak defective mitre rail.

It is expected that the installation will be made sometime in late fall using the original elastomer pads which are performing well.

We presently have four sets of this new and improved mitre rail on order to be installed on the swing bridge which carries over 200 trains a day. I had hoped to be able to report on the installation; however, due to various reasons the fabrication is not complete as yet.

Moveable Bridge Track Structure

No talk on Amtrak high-speed mitre rail is complete without briefly explaining the composition of our track structure on moveable bridges. Amtrak uses welded rail across all moveable bridges. Our standard is the use of elastic fasteners or conventional cut spikes and rail anchors. No thermit welds are allowed on moveable bridges. This limits the length of a welded string to whatever the welding plant produces, which is usually around 1,500 feet. Ties are secured to stringers every fourth one with hook bolts. Spacing blocks are between each tie. Joints are secured with high-strength bolts and glued joints. Expansion joints are provided on the ends of the fixed span within one rail length of the mitre rail. This is to prevent the end of the mitre rail from moving toward or away from the moveable span. This has been very successful in eliminating the use of the summer and winter rails in connection with the improved one-piece mitre which handles the expansion and contraction of the moveable span. All joints to the mitre rails and the expansion joints are glued joints.

Within several months after delivery of the mitre rails for the swing bridge, we have another set for another double track swing bridge, which is the same as the first with the exception that it will be mounted on Ekkie (Azobe) wood ties. Ekkie is a very hard dense African wood which needs no treatment to prevent decay. If the Ekkie proves successful, it will be an available and more economical alternative to the steel ties.

This concludes my talk on Amtrak's high-speed mitre rails. Thank you for your attention. Are there any questions?

Member: You mentioned the shorter lengths on the bridge, do you use a glue bonded joint to tie those strings together?

Mr. Shaw: Yes, we do. Any other questions? Thank you again. (Applause)

President Lewis: Thank you, Mr. Shaw. We will adjourn for a short break and reconvene here at 10:10 a.m.

Recess

President Snyder: Will everyone please be seated. Thank you. At this time I would like to call the meeting back to order and call on Mr. Byron Burns who will introduce the next speaker.

Mr. Burns: Thank you, President Snyder. Many of those present, including myself, have been involved in one phase or another of railway line clearance improvements for various load configurations, such as double-stack container cars. One of the initial steps in the improvement of clearances on designated routes is the determination of the amount of clearance improvement required at each obstruction. Our next speaker, Mr. Lars Lundberg, will present one method of determining existing clearances on structures.

Mr. Lundberg is a civil engineer from Sweden. He has practiced in this profession since 1969 and has worked in the area of railroad applications since 1973. He is one of the designers of the photogrammetric clearance system that is the basis for the SRS clearance measurement car.

May I now present Mr. Lars Lundberg.

SRS CLEARANCE MEASUREMENT CAR

Lars Lundberg

SRS America Company, Inc.

Good morning, members of the Roadmasters and Bridge and Building associations. My name is Lars Lundberg with SRS-America. It is an honor for me to participate in this meeting and I hope my presentation will be understandable despite my Swedish accent.

This presentation will technically describe our clearance car named STEFO. By the way, SRS stands for Swedish Rail System, and is, of course, often confused with another big contractor in the railroad area.

STEFO, another short name, stands for Stereo Photogrammetry and that is the basis of our clearance system. Photogrammetry is the science of measuring in pictures. We divide photogrammetry in two sections, single and double picture measuring.

We use the double picture method, which gives us measurement in three dimensions with a very good accuracy. Before I talk more about the theory behind the STEFO I would like to give you some history from the development of the system.

It started in Sweden back in 1971 when the Swedish State Railway found out that their old ''Feeler Car'' did not match the new requirements for the clearance data.

SJ, the short name for the Swedish State Railway, did a lot of research to find a good concept for a modern clearance method. It was important to improve the following from the old method: short track occupancy, better accuracy, result in coordinates for future developing into a computerized system, and flexibility, meaning there should be a chance to get more information from the field result. The answer to all these requirements was photogrammetry.

Short track occupancy is taken care of, a picture can be taken in speed. No manual measurements need to be taken. The accuracy can be very high with the right tools, a high-precision camera, the right number of well-known targets, and the optimal distance between the two stereo-mounted cameras.

As the pictures are processed in a stereo-instrument, we get the result either as a draft, or in coordinates, or both. Under the flexibility concept we have two very important features coming with the photogrammetric method. One, we get pictures of the structures for further study in the office, and it comes with the method. Two, we can always go back to the pictures and measure more points, or different sections if we found out other requirements after our field work is done. And, as the old saying goes, a picture tells you more than a thousand words.

There were many months of tests between the first theoretical discussions and the first STEFO-vehicle. But here is the first little track car with two Hasselblad ''moon cameras'' on the roof, and a reference trolley for the targets and the ''judging frame''.

This first vehicle was used for three years and SJ took about 3,000 models during that time. Model is the photogrammetric word for two pictures in stereo, giving us a stereo model. So 3,000 models are 6,000 pictures.

This picture shows the principal of a stereo model, a left and a right hand picture of the object that shall be measured. In this case it is a tunnel cross section.

The first version of STEFO, of course, had some bugs in the system. The operators soon found out that the camera's position was too inconvenient, especially in bad weather. To go out and climb the ladder all the time was not only inconvenient, but also unsafe. The most important improvement for the next STEFO was to get the cameras indoors.

In 1976 there was no one in Sweden who was thinking in terms of a high rail vehicle, so the second model of the STEFO was built on a Matisa rail measuring car.

There was, of course, a lot of other important improvements on this machine. The reference frame was to some extent adjustable, the trolleys were now good for about 40 miles an hour speed, and the cabin gave working space for five people.

The strobe light and the cameras were placed together, and the "camera doors" were automatically opened when a picture was taken. The strobe light was now of very high quality, and both night work and diesel-smoked tunnels gave enough contrast with these reflectors.

This new STEFO turned out to be a well-prepared concept, and it was successfully used from 1976 through 1985 in both Scandinavia and in North America. In 1979, Mr. Glenn Graff of Amtrak, first heard about our new concept in clearance measuring. He got interested, and in January, 1981, the STEFO and I took our first step on American ground. We traveled the whole way by boat from Gothenburg, Sweden, to Baltimore, Maryland, and believe it or not, without any major damage.

Our first mission was to measure the B&P tunnel in Baltimore, both the No. 1 and No. 2 track and the gauntlet track. Mr. Graff did, of course, check our progress on the first mission, and he was satisfied. He had some good suggestions to adapt the system even more for American railroads. Some of those changes had to wait for a couple of years, like the high rail concept, but most of them have been accomplished and do help the system to operate better here and in Scandinavia.

The rail-bound STEFO operated in the United States a couple of months between 1981 and 1984. It was sent over by boat from Sweden on two different occasions. We did most of the work for Amtrak's Northeast Corridor and Metro North in New York.

After this review I think we are ready for the existing high-railed STEFO, the product of 15 years of experience, operating in both North America and Scandinavia, for clearance and track center measuring. It is built on a Volvo F6 chassis and has a total weight of 29,000 pounds. The engine is a powerful 175 horsepower turbo diesel. We have a generator for AC current, both 220 and 110 volt. The cabin is air-cooled and soundproofed. The track speed is a maximum of 45 miles per hour in both directions.

It has a hydrostatic drive for maximum traction and brake capacity. The rubber wheels are not down when working on track. This concept is an SRS invention and is protected by a patent. We use this concept for many kinds of rail work equipment, including the over and under bridge inspection car.

We think there are many advantages with this high rail concept if we compare it with other systems. One is, we only need a road crossing about 12 feet wide to get on track. Two, we have traction and brake function similar to a rail-bound vehicle; and three, the hydrostatic drive utilizes electrical maneuvering, useful in much of our system. The STEFO has two driving panels, one in the Volvo cabin and one in the STEFO cabin. The bridge inspection car has three driving controls: one in the basket, one at the base of the crane, and one in the Volvo cabin.

The following pictures show the principal of how to get STEFO on track and how to assemble the system. It only takes three minutes to put the machine on track and another 30 minutes to assemble the system. We approach the track at a 90 degree angle and align the bogie with the track and lower it by the hydraulic power. Then we switch to driving on rail and use the front rubber wheel to align the front end to the track. We then lower the front rail wheels. If we are using a heavily traveled stretch of track we go into a siding and assemble the reference trolley. The trolley is taken down to the track on ramps and is maneuvered by a five-ton winch. We hook it to the STEFO vehicle with a light towbar, and we connect the electrical cables.

And, if we do everything correctly, this is the result: a display showing picture number, film number, and milepost. A pendulum showing the super elevation, a curve device showing the degree of curve, and a frame adjustable from four to eleven feet from center line of track and from 15 feet to 27 feet from top of rail.

The 21 feelers are for judging purposes only. They are made of fiberglass. When a feeler touches something the operator takes a picture.

The base in a photogrammetric system is, of course, the cameras. We use two Hasselblad super accurate MKW-E cameras, which are basically the same cameras used by NASA in the Apollo moon mission. The system uses 70 milimeter film in cassettes with 70 pictures in each. To save time out on track, we preload six magazines, equal to 240 stereo models.

The cameras and the strobe lights are mounted on a beam easy to reach for maintenance or for changing magazines. Also note the video camera in the upper left corner. We also have a monitor and a VHS video recorder on board. The video is used for continuous recording of everything we measure. The customer gets the tape as a part of the result. Furthermore, we have a voice tape recorder for other important information, such as name of structures, signal number, switch number, and so on. All this information is later put together with the coordinates from the photogrammetric measurements. We also have our own radio on board programmed for all the railroad's frequencies.

Now let us look briefly into the theory behind the STEFO concept. As I mentioned earlier, we use the double picture photogrammetric method. That means we get measurements in three dimensions, x, y, and z. We get them because of the difference in angle to the object from the two cameras. It is very important in any photogrammetric system to have well known targets. They are the reference for the scale. We use professional surveying to get our eight targets accurately measured. In our STEFO language, objects are named "fomul". It is a latin word and means "obstacle". We can measure fomuls, with maintained accuracy, out 10 feet from center line of track and up to 27 feet above the top rail.

This is a stereo model, the two pictures with a base. In the STEFO case it is six feet between the cameras. There is an optimum for how wide the base shall be.

This is the SRS-America portable stereo comparator, the instrument in which we measure most of our clearance dimensions. It is linked to a personal computer and gives us coordinates in x and y and z within three-eighths of an inch RMS accuracy. Together with the coordinates each picture or model also contains the following information: name of the customer; the date of measuring; track segment; track number; the degree of curve; the milepost in a thousandth of a mile decimal; the name or number of the structure, and the film and frame number. We also store the direction in which the camera is facing. It is very important information and enables us to place the obstructions on the correct side of the track under all circumstances.

There are many formats for storing the clearance information. The two most common are:

1. Hard copy diagrams on stable base material from our plotter.
2. Coordinate dimensions on floppy disk in MS-DOS format.

The program is a very good base for many railroads today to adapt their clearance data into a computerized system. We can tailor the program for different railroads' needs. It is possible to get a plot function and, on request, we can add other specifics into the program.

In 1985, we found a great interest from many railroads for a track center measuring system. So far, the only existing concepts seem to be two, a high rail vehicle and a measuring tape. We did some research and the result was a no-contact laser system named "optocator". The optocator can measure 16,000 points in a second within a thousandth of the measuring distance in accuracy. It has a measuring range from two feet to four feet. It also has an analog output for each connection to various computers. We linked our optocator to a personal computer with a 20 megabite hard disk.

Because of the measuring range of the optocator, we needed to add an adjustable boom to complete the track center system. This boom is adjustable in length and height and we can swing the boom to both sides of the working track. We can measure track center distances from 10 feet up to 18 feet. I think it is important to point out that we do not foul the adjacent track under normal circumstances. The software allows us to use the optocator in different angles to the track, depending on the various track conditions.

The optocator measuring probe scans the inner rail of the adjacent track once every second. The value is stored in the on-board computer together with the milepost in a thousandth of a mile decimal. Other important data stored is super elevation, degree of curve, track segment, and track number for all the tracks involved.

We also get continuous reading on our onboard printer if desired. We have a minimum track center software linked on line for immediate access. With this function we can provide a roadmaster his minimum track center immediately after measuring his stretch of track.

Running speed, when performing track center measuring, is 10 to 40 miles per hour in both directions depending on track condition. The track center distances will be measured within plus-minus one-fourth of an inch accuracy.

We have two more applications for our optocator measuring system. One is measuring of high and low level platforms and the other is measuring bench walls in narrow tunnels.

If we perform track center measuring on freight railroad territory, with normal track time, we will measure 150 miles of double track a day, including about 10,000 measured points. If we perform clearance measuring on one track in freight territory, we can measure about 100 miles a day. This includes approximately two models a mile. Finally, if we perform clearance measuring in commuter territory we can figure about 65 miles a day and approximately 250 models.

Thank you for your attention.

Mr. Burns: I will now call on John Horney to introduce our next special feature. John.

Mr. Horney: It is a pleasure for me to introduce our next speaker, Mr. Jim Beran. Although Jim was born and raised in Nebraska, for some reason he elected to pursue his college career at Notre Dame where he received his Bachelor of Science degree in 1969. After graduation from Notre Dame, Jim went to work for Chicago Bridge and Iron for a year, and in December, 1970, he went to work for the Union Pacific Railroad. Our football season and our bridge office has not been the same since. Since that time, Jim has worked his way up the ranks from draftsman to designer, until 1986, when he became general structures engineer for Union Pacific and Missouri Pacific during the time of the merger. Then in January of this year, Jim became chief engineer of design and structures for the Union Pacific. With that, I offer you Jim Beran.

TUNNEL ENLARGEMENTS ON UNION PACIFIC

J. R. Beran

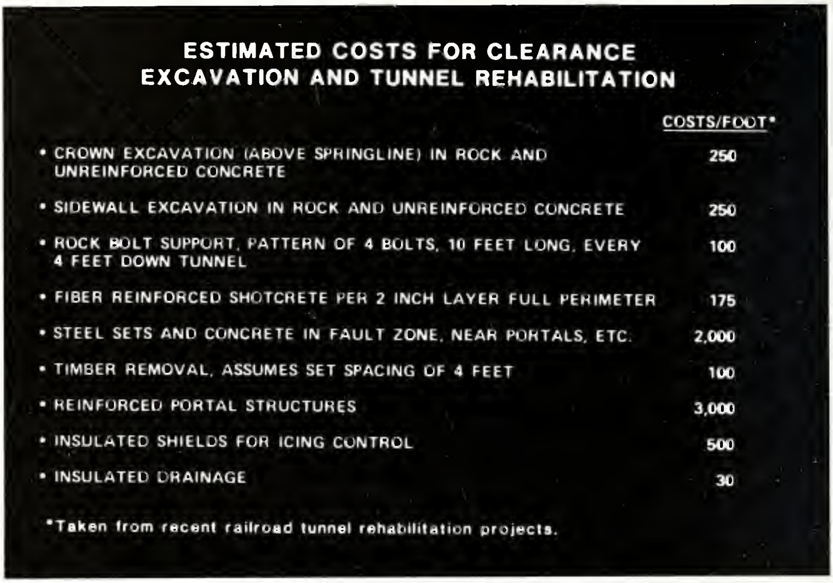
Chief Engineer of Design and Specifications
Union Pacific Railroad

I am sure that most of you are aware that John Horney took a dive off of one of our bridges back in July. This morning he told me this most fantastic story about his flight to Chicago. It seems that one of the stewardesses on that flight was a faith healer and she insisted upon trying her product on John. John said she was rubbing his hip and his leg and she tried this for about five minutes. I asked John what the result was, and John said that he felt a lot better, but his leg still hurt! (Laughter)

To give you a little background, I want to take you through a very brief summary of the mergers of the UP and what it meant to our tunnel program. This is the original UP system until the early 1980s. The red dots on the slide indicate locations of our tunnels. Then, in 1983, we merged with the Western Pacific and Missouri Pacific. This is the Western Pacific system, and you can see the concentration of tunnels. There are a lot of little tunnels in Southern California all bunched together. The Missouri Pacific had seven tunnels. Today, General Dodge, I am sure, would be very surprised to find the accumulation of railroads that now make up the Union Pacific that he started back in about 1860. Today, it looks like this. Again you can see the location of tunnels on the railroad.

This is a schematic showing the summary of how many tunnels we have. There are 114 individual tunnels, and that totals up to almost 26 miles if they were end to end. We still have several miles of timber lining in our tunnels, primarily on the Beaver Line in Northern California. We have 97,000 feet of concrete-lined tunnels; 18,000 feet of rock tunnels. You can see the shotcrete lining. Most of this is the result of the work we did in the 1984-1985 period. We have about 14,000 lineal feet of shotcrete-lined tunnels.

The first tunnel I was involved in was the Aspen Tunnel in Western Wyoming in 1974. This is an original UP map and is a little dif-

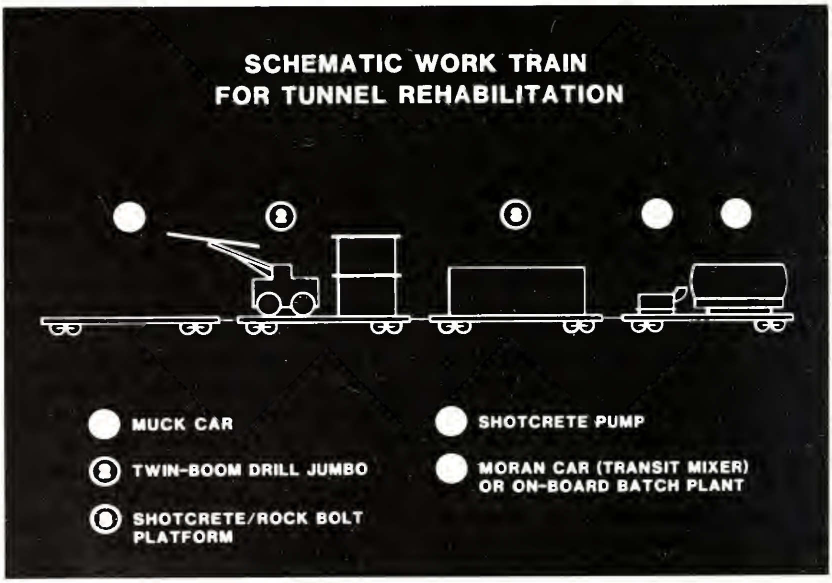


ESTIMATED COSTS FOR CLEARANCE EXCAVATION AND TUNNEL REHABILITATION

	COSTS/FOOT*
• CROWN EXCAVATION (ABOVE SPRINGLINE) IN ROCK AND UNREINFORCED CONCRETE	250
• SIDEWALL EXCAVATION IN ROCK AND UNREINFORCED CONCRETE	250
• ROCK BOLT SUPPORT, PATTERN OF 4 BOLTS, 10 FEET LONG, EVERY 4 FEET DOWN TUNNEL	100
• FIBER REINFORCED SHOTCRETE PER 2 INCH LAYER FULL PERIMETER	175
• STEEL SETS AND CONCRETE IN FAULT ZONE, NEAR PORTALS, ETC.	2,000
• TIMBER REMOVAL, ASSUMES SET SPACING OF 4 FEET	100
• REINFORCED PORTAL STRUCTURES	3,000
• INSULATED SHIELDS FOR ICING CONTROL	500
• INSULATED DRAINAGE	30

*Taken from recent railroad tunnel rehabilitation projects.

Estimated costs for tunnel clearance.



SCHEMATIC WORK TRAIN FOR TUNNEL REHABILITATION

MUCK CAR
TWIN-BOOM DRILL JUMBO
SHOTCRETE/ROCK BOLT PLATFORM
SHOTCRETE PUMP
MORAN CAR (TRANSIT MIXER) OR ON-BOARD BATCH PLANT

Schematic work train.

ficult to see. This is a blow up of the map and you can see two lines here near the top center. The top line is our Altamont Tunnel. Our double track main line in Wyoming is spread out quite a ways at this location, and the lower track has the Aspen Tunnel on it.

We had some very good geological mapping of the tunnel from the original construction in 1900. There are some pretty extensive areas with very loose material, including mud and shale and so forth through parts of the tunnel, that presents quite a few problems.

John Horney did this drawing back in the days when we were both draftsmen. I think those are Crickets. I think that was the kind of car he was driving at the time. (Laughter) Anyway, they show the reason for the work we did in the Aspen Tunnel. It had some very restrictive clearances and you can see, very faintly, over the top of the third car, where the original outline of the tunnel was. We had the work completed, essentially as shown by the outer perimeter there.

What we did was lower the floor of the tunnel. There were three basic types of original construction. In a large portion of the tunnel, where we had the unstable soil, they had a lot of steel ribs. When we lowered the tunnel floor we tried to continue the steel ribs around through the new invert of the tunnel. That is shown on the right. There were two other basic types of construction in the tunnel where they had varying degrees of force. In some cases we just put rail down in the invert, and in some cases we put a steel beam down there to take the horizontal thrust.

This picture shows a section of the tunnel as it was initially excavated by the contractor. Here is a section where they had the steel ribs. We excavated it, exposed the ribs, and then cut them off all to a uniform line so we could extend them with steel beams around the perimeter of the invert.

This is the section that didn't have the steel ribs. Now you can see up above that we did put horizontal beams in to hold the thrust from the soil. The spacing of the beams varied by the amount of the load we had on the sides.

Here are some of the vertical beams holding up the side wall. After the invert was poured, we are about ready to start forming and pouring the side walls. Here we are forming the side walls. You can still see the horizontal thrust beams up above. Here is the final product just before the track was put in. It turned out to be a pretty nice looking job. One of our former chief engineers called this the keyhole tunnel because of its shape. In the areas where we had the mud and shale we had a lot of pressure on the side walls. We actually got to the point where the side walls pushed in enough to buckle our horizontal thrust beams.

During the original construction they apparently experienced some of the same difficulties we had. Here is another original picture during construction where they had all the steel ribs.

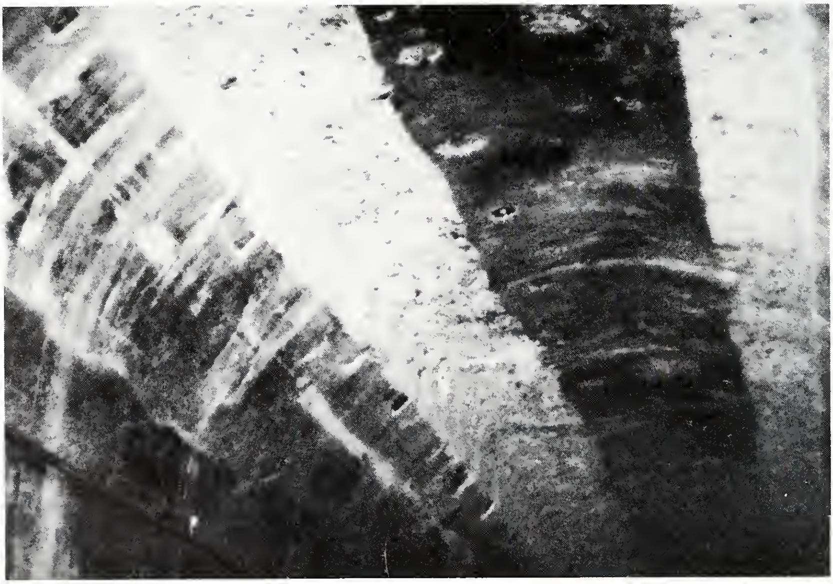
Back in 1900 when they drove this tunnel, they installed an air-handling system for fresh air. We had to do the same thing when we did our work. I like to look at these pictures of the old miners and try to imagine what they really looked like if they had the same type of photographic equipment we have today. In a lot of respects they haven't changed a lot. You can see this guy is dirty. It is dirty work today when you work in tunnels and our guys still wear mustaches and bikinis. (Laughter) Actually, Joe Lileikis is going to use that picture in a presentation tomorrow but I stole it from him for now.

There are two things that we started experimenting with when we did that tunnel. One was rock bolts. We didn't use them very extensively and as it turns out, the rock around the perimeter of the tunnel lining wasn't adequate to hold a lot of load on the concrete shell but we did install them in some places and it did help out. They were mechanical-type fasteners with a spread anchor on the end. Second, we did a little bit of shotcreting. This was for cosmetic purposes to smooth up the joint between the original concrete and the new concrete construction.

There are three main reasons we do tunnel work and I am sure that this is the same for everybody. One of the primary reasons is to increase clearances. That is the driving force today behind most of our tunnel work. We also do tunnel work to reduce maintenance costs. In a lot of cases with the old timber linings we are forever in there replacing the timber sets. Tunnel work is also done to improve the structural integrity of the tunnels.

Shortly after the merger with the WP, we started analyzing the type of work we would have to do on the WP to improve clearances.

Roadheader at work.



Roadheader results.

They had a lot of timber-lined tunnels, and we put together quite a few different types of options for upper management showing them what the cost would be for various types of clearances. At the time they weren't sure what we needed for clearance. This chart shows that we gave them costs for eight feet wide 19 feet high double-stacks; eight feet wide, 20 feet high; and eight feet wide 26 feet high. As it turns out, the first time we went through the tunnels on the WP, we went with 19 feet six inches high, and eight foot six inches wide. At the time, I guess, marketing had been talking to shippers and they said there were two types of containers — big ones and little ones. They said there would not be enough big ones around that we would ever have two of them together. Later on, that turned out to be not true and we are going through those tunnels again today because of that.

I imagine almost everyone has seen this type of thing in their tunnels. There are a lot of indications that they have been hit. We saw this in almost every tunnel we had and we knew that the bigger loads were still to come.

The first time through the WP was during the 1984-1985 period. This is a summary of the work we did in the tunnels. We did a lot of shotcrete work. We removed all the timber sets from the main line tunnel. We spent about $5.6 million during that period of time and that does not include over a million dollars that we later spent on Tunnel No. 3. We daylighted that entire tunnel. It turns out that we spent about $7 million total the first time through these tunnels.

Primarily, when we shotcrete a tunnel, we normally go in with a pattern of rock bolts. Basically four rock bolts across on four foot intervals along the length of the tunnel, even in places that it wasn't apparent that we needed them. Of course, there are cases where you had slabs and rock that were obviously going to get loose someday and we would rock bolt those. We then covered the whole thing with shotcrete. Most of the time we put two inches on the side and four inches in the top. The shotcrete would hold the smaller rocks in place and they, in turn, would hold the bigger rocks in place and this seems to have worked real well. I am not aware of any maintenance in these tunnels since we did that work.

This slide shows a little bit of the reasoning we used in deciding to make most of the clearance improvements in the crown of the tunnel instead of doing the work in the invert. Of course, if you work in the invert you have to make appreciable improvements in the clearance and you have to take the track out and that is almost impossible to do without having the track around the clock for extended periods of time. Whereas if you work in the crown, you can get in and out and you can work in as short a time as a four-hour block. We have worked in a lot shorter blocks than that and you can still get in between the trains and do some meaningful work.

One of the best tools in doing our tunnel work is our laser clearance car. Before we do any tunnel we go through and take measurements at ten-foot intervals. The results of those measurements are diagrams like this. It is very useful in estimating quantities and it is useful in being able to determine exactly how much work the contractor did when you talk about pay items and so forth.

When we went into the tunnels on the WP, the first thing we did was determine exactly how much of the tunnels we could daylight. The more we could daylight, the better. Now obviously if you have loose materials, as you saw in this slide, it is better to daylight it than to try and support it. I'm going to go through several slides here. This is tunnel No. 41 on the WP and we are in the process of daylighting it. The first thing we did was to take most of the overburden off and then as we went through we would knock down segments of the tunnel. We tried to only knock down in the first half hour as much as we could clean up the next nine and a half hours. The first thing we did was try to put some flat cars in there so it would fall on the flat cars and then we would pull it out. It didn't work very well. What a mess. There is an unbelievable amount of timber. Then we got big trucks in there and dumped it into the trucks. After the truck pulled out we put an end loader in and cleaned up the mess. All in all it worked fairly well. We got through on schedule and of course, the backhoe you can see on the left side there, did two things at once. It knocked part of the tunnel down and the rest of the time it was removing the sides and loading it into trucks. We had trucks backed up three or four at a time ready to be loaded. It didn't always go just as we liked. This one took a little longer to clean up. I was always

Drilling for rock bolts.

Portal extension.

Portal extension.

amazed at the miners who originally drove these tunnels. This was in very loose material. You can see the amount of packing they put above the top of the tunnel. They were a bunch of brave souls that got up there and did that packing by hand from below. We had already taken about 30 foot of overburden off the top of it at this point.

This is another tunnel we daylighted. It is actually a water shed as you can see and it was known as tunnel No. 12 on the WP. We put a catch wall on top of the cut to collect the water and ran it through two vertical stacks recessed into the base of the cut and then eventually underneath the track through some culverts. It has been working very well so far.

After doing all the daylighting we could on the outside, we would start removing timber sets from the inside. Most of the time we experienced little difficulty. The rock was fairly sound. We would get a backhoe and knock down a few sets, then load up and haul them out. It worked pretty well. Here is one of the stacks of material we accumulated on the outside of a tunnel. There got to be some tremendously large stacks of lumber. It was the contractor's responsibility to get rid of it. Most of it was hauled off by local people. We built an access road where they could safely get in close to the timber and load it up and almost all of it disappeared overnight.

Our next segment is on portal work. Here is a picture of an oak timber portal we are removing. The first thing we did was remove all the old structure and when it got to a stable point we would start putting in steel ribs which were going to be the foundation for our new portal extensions. Here is a series of slides showing the process of this work. You will note that we took the portals quite a distance out of the face of the tunnel because we wanted to make sure that they caught all the loose debris which would eventually fall off the face. That is part of the reason for these portals to protect the track from any debris getting on them unexpectedly in the future.

The steel ribs make a very good basis for tying the forms and reinforcing. It was a very simple process to construct.

Here is a portal that we removed from a rock tunnel. When we took it out we didn't build a new concrete structure. What we did was rock bolt and shotcrete the face of the rock and that has been working very well. When removing the timber sets we would install the rock bolts. Here is a picture installing rock bolts in a tunnel. We used epoxy sausages inserted in the hole and then the rock bolt would be spun and driven into the sausages mixing the epoxy. This epoxy will set up in varying lengths of time. Normally, the first ones in the hole would set up in five minutes. After they are set up, we would draw the rock bolt up tight with a washer and nut on the end and then the rest of the epoxy sets up afterwards. It is much more effective than a pure mechanical type of rock bolt as I showed you before because the entire length of the rock bolt is tied into the rock. We also installed steel sets where necessary. For example, here, sets are in their final location. They are basically supporting rock slabs. There wasn't much small material to fall out. In areas where there is a lot of small material, we would put steel channel lagging between the sets, as you can see here, and then grout it afterwards. Near the top on the left, you can see grout holes. So, we would grout them up tight against the face of the rock where the soil is behind them. Here is a picture installing steel channel lagging.

Most of the time we had to install steel sets near the portals on the inside of the tunnel. That is where most of the loose material is and most of the hazard. Once into the interior, by and large, it was pretty solid rock material. This is a very handy tool to use in construction. If you are inside the tunnel and have some loose material and dangerous situations, install a steel set and then project or cantilever channels and beams to hold the tunnel four or six feet ahead of yourself until it is stabilized. Then go in and put another set in and repeat the process.

A lot of the sets were manhandled in place, and some of the crews could put a steel set in in about 30 minutes. They did real well just working off these hydraulic-lift platforms.

Here you see a lot of cut in the rock. Sometimes we had to cut the steel to make it fit, but by and large it worked pretty well.

There are a few rock bolts in there. I can see three of them. After we had gone through and rock bolted, we went through and washed it to take most of the smoke and soot off the walls so that the shotcrete would adhere to it. Then we would start the shotcreting process. Along with that, in some tunnels where we thought it necessary we installed some wire mesh. We are not going to be using wire mesh anymore. We will be concentrating on using fiber-reinforced shotcrete. It is a little difficult to see in this slide, but all of that has steel mesh pinned to the face of the rock. We worked off several different types of platforms to shotcrete.

There is a tremendous amount of rebound when you shotcrete. You are lucky if you get ten percent or less of the shotcrete that goes through the nozzle on the track and ninety percent on the walls. That's pretty good if you can get those kinds of results. A lot of the time we got large amounts of shotcrete on the track so we put plastic over the ballast and rail before we shotcreted, then pulled it up afterwards. Some of the contractors managed to keep the track fairly clean. Here is another tunnel that we eventually shotcreted on up the face. We would scale it and make sure that we wouldn't have any real loose rock, then we would rock bolt and shotcrete the face of the tunnel. At that time with nineteen and a half foot high double stacks we found that in a few of our concrete tunnels it was necessary to go in and skin out a little bit of the concrete to get our desired clearances. There weren't too many of these tunnels that we had to do at the time. It was all hand chipping. This is the setup that we used when we went through these tunnels and did the chipping. Pressers, a couple of jumbos. We used this old crane to pull them in and out of the tunnels.

This is a summary of what we found our cost to be on the different types of work. The reinforced portals were about $3,000 a foot; rock bolts in a pattern of four bolts, 10 feet long every four feet down the tunnel were $100 a foot through the tunnel. Side wall excavation of rock and unreinforced concrete was $250 per foot. With steel sets and concrete fault zone, we spent about $2,000 per foot a tunnel.

In conclusion, this basically is the same thing as my triangle at the beginning. You can improve clearances on a tunnel. You can stabilize the tunnel and reduce maintenance costs fairly easily without taking the floor of the tunnel out and undercutting the track. After that work was completed, the next thing that we heard from our marketing and sales people is the way of the future will be two large containers. That means our clearance on the top of the car is going to be 20 feet two inches high and we are going to go with our six inches of clearance outside the car, thus needing about 20 feet eight inches. We ended up going 20 feet nine inches as our new desired clearances through tunnels. The shippers are convinced that they are going to have to have this clearance in the very near future so we set about trying to analyze all of our major routes on Union Pacific, identifying bridges, tunnels and viaducts that would restrict the clearances for these cars and we are now in the process of improving those clearances. Right after we established our new clearance criteria, the first tunnel we got into was the Conway Tunnel about 30 miles out of Little Rock, Arkansas. It had some serious problems. There is a highway over the top of the tunnel and you can see that the loose material falling into the tunnel through the lining is making deflects on the surface of the highway. Those were the types of problems we had up above. Here is an indication of what it looked like on the inside.

In this tunnel we did just about all of the major types of work. This is the first tunnel we used the roadheader in to improve clearances. All through the length of the tunnel there was restricted clearance in the concrete lining and we used the roadheader just to go in and chew the concrete and get up to the required clearance.

This is after the roadheader has gone through. We would pin, with rock bolts, the remaining lining up to the surface of the rock. We actually made it all the way through the lining at this spot. You can see some of the timber packing up behind there, so there wasn't much concrete left. What we did have left we rock bolted and then grouted the void.

Here is a section of the tunnel that has been completed. We pinned back a lot of the portal areas to try to reinforce it. Here is a section of the tunnel right below where the roadway was which was very unstable. We are installing the steel sets and trying to keep the pace of about one set per day to get through that area. We didn't always make it. Sometimes it came down unexpectedly. It was a fairly dangerous situation. We didn't get anyone hurt through this whole job.

I was surprised that the state highway department was not as cooperative as they should have been on that whole project. We were trying to save their road.

We got back into the tunnels in the Feather River area on the WP and again took our clearance car through all of them. You can see the little circle in the upper lefthand corner there. That circle shows the extremes of our new clearance requirements and right at the bottom of the circle you can see a little dimple in the line. That is where we went through the first time and chipped it out. Now we are going to have to go in there and make some major clearance improvements. This is on the southern point of one of the Southern Pacific tunnels. This is in pair track territory. Traffic runs one direction on our track and the other direction on theirs. In order to be able to handle those cars both ways we are going to have to make some changes in four SP tunnels. This is around the Elko, Nevada, area. The tunnels on the SP were timber lined. They have filled the void between the timber sets with concrete.

This is a summary of the benefits and nonbenefits for using roadheaders. It says over there on the right that roadheaders are good in soft and medium rock. We are finding that we can go into the more medium rock categories. It doesn't have to be that soft. You might have to replace teeth on the bits a little more often. It also says unreinforced concrete. We are not trying it in reinforced concrete. The Burlington Northern used a roadheader on some of their tunnels in reinforced concrete and it seems to have worked fairly well.

Here is a picture of a tunnel after a roadheader has gone through and chewed the lining out to get the clearance.

Here is another method that was used on the Burlington. This is a saw mounted on top of a hi-rail van that I think moves at about a foot a minute and makes the initial vertical cut. The rest of it is chewed out with a roadheader. In this case you can see the vertical cut on the outside was made by a saw and the remaining material has been chewed out with a roadheader. This is all roadheader work here. If we got fairly deep in the lining, the geologist would recommend that we pin the lining back on either side of the cut into the rock. It is really a judgment call on when you have to do it. Obviously, to get all the way through the lining would be trouble but in most of the cases they will give you some kind of judgment on how sound the rock is, how much void there is between the lining and the rock and how often you have to put in the rock bolts. So far we haven't had any problems. I also don't believe that the Burlington has had any problems on their tunnels they did up in the gorge area in Oregon.

Mr. Horney: Jim, thank you very much. Does anyone have any questions of Jim before we let him go?

Member: In some of the areas where you shotcreted have you had any water problems and how did you accommodate those?

Mr. Beran: As a matter of fact, when we first started shotcreting our consultant told us that we wouldn't have any water problems if the shotcrete isn't so dense that water won't seep through it at a slow rate. We found that to be true in some areas where the water pressure was very low, but if we have more water pressure we core it and put plastic pipes to let the water flow freely through the lining, so it is not much different than if you had a solid concrete lining.

Mr. Horney: Anyone else? Jim, thank you very much for that fine presentation. I'll now turn the program back over to Hugh Fuller who will introduce the final presentation of this joint session. Hugh.

Mr. Fuller: Thank you, John. Our next speaker today is Doctor Benjamin J. Allen. He is Professor of Transportation and Logistics, Distinguished Professor in Business Administration, College of Business Administration at Iowa State University. He has a Ph.D. in economics from the University of Illinois. He also has a Masters in economics from the University of Illinois and a Bachelor of Science in business economics from Indiana University.

Dr. Allen has experience in teaching, government, and consulting. Before joining the faculty at Iowa State University in 1979, he taught five years at Washington State University. In 1976 he served in the Office of Transportation Regulatory Policy of the United States Department of Transportation as a Brookings Economics Policy Fellow. He has been a consultant with the Office of Rail Public Counsel, Federal Trade Commission, Dayton Power and Light Company, Conrail, Burlington Northern Railroad, American Carriers, Inc., and the United States Department of Transportation. During the 1986-1987 academic year he was at the University of Illinois where he was the Visiting McKinley Professor of Economics and Public Utilities. In 1988 he was selected as the inaugural Distinguished Professor in Business Administration at Iowa State University. He was chairman of the Department of Transportation and Logistics at Iowa State University from 1984 to July, 1988.

Dr. Allen's research interests lie in the area of the impact of transportation regulation and promotion on resource allocation, income distribution, and managerial decision-making. His research results have been published in several journals, including the "American Economic Review", "Quarterly Review of Economics Business Logistics", "The Logistics and Transportation Review", and have been used in Congressional testimony by the United States Secretary of Transportation. He has also received several United States Department of Transportation research contracts. In 1988 he was invited by the Polish State Railroads and Central School of Planning and Statistics to give a series of lectures on transport economics and policy in Warsaw. He is a member of the editorial boards of the "Journal of Business Logistics" and "Transportation Journal". Dr. Allen.

ARE CHANGES IN RAIL LABOR/ MANAGEMENT RELATIONS KEEPING PACE WITH CHANGES IN THE RAIL/TRUCK COMPETITIVE ENVIRONMENT?

Dr. Benjamin J. Allen

Director, Midwest Transportation Center
Iowa State University

Introduction

I first want to thank Mr. Ray Snyder and Mr. Hugh Fuller for providing me with the opportunity to be with you this morning. We at Iowa State University take transportation research and teaching very seriously, so when an invitation arrives to talk about transportation, we jump at it. Our transportation program was strengthened recently by the United States Department of Transportation's selection of Iowa State University and the University of Iowa to be the site of the University Transportation Research Center for Federal Region VII. Region VII includes the states of Iowa, Nebraska, Kansas and Missouri. The Midwest Transportation Center, which will be housed at ISU, is a rare example of a program on which the two major research universities in Iowa have agreed to jointly participate.

I was asked to make a presentation in the area of transportation economics. For those of you who attended this conference in Kansas City last year, you are well aware of the entertaining and substantive talk given by Dr. Morton Marcus of Indiana University. I will not attempt to compete with him. We do have one thing in common—Indiana University. I attended and graduated from the Bloomington school. My timing was wrong, however. Indiana University has had two great basketball coaches. Branch McCracken, who won two NCAA championships, retired in the spring of 1965, and Bobby Knight, who has won three NCAA championships so far, started coaching at IU in 1971. Yes, I started college in the fall of 1965 and graduated in 1969. The fact that the Hoosiers played in the Rose Bowl is an indicator of how strange the sports world was at IU at the time.

My presentation this morning is on the relationship between changes in the rail labor/management relations and changes in the rail/truck competitive environment. This issue might not be getting much attention by the political candidates, but it is in the rail industry with the Chicago and North Western, Burlington Northern, CSX, and the other railroads attempting to resolve some basic labor issues. We in Iowa followed the crew consist labor issue involving the Chicago and North Western and the

United Transportation Union very closely. The Chicago and North Western carries more than half of the grain shipped in our state and employs more than 2,000 men and women.

The conclusion reached in this presentation is that although changes have taken place in rail labor/management relations since regulatory reform was implemented around 1980, these changes have not kept pace with the changes in the rail/truck competitive environment. The reasons for and implications of this failure to keep pace will be explored. Let us first look at some of the changes in the level and cost of labor in the railroad industry.

Change in Rail Wage and Employment Levels

Historically, labor costs have represented the largest cost component of most of the modes of transportation. Transportation workers generally received higher wages than the average industrial workers and were, in general, more highly unionized. In the era of strict economic regulation, tight entry regulation in the air and trucking industries and collective rate making in each of the modes resulted in near uniform pricing by all competitors in the same market. Rate regulation and required publication of rates in theory protected the public, but in fact, in many cases, were simply used to enforce the behavior of the members of the transportation cartel. Increased labor costs were merely passed on to the consumers of transport service—either shippers or passengers.

The economic reforms passed in the late 1970s and early 1980s were certain to upset this cozy, cartel-like arrangement. In fact, like most cartels, the transportation cartel, with the ICC playing the role of the cartel manager for surface transportation, was becoming increasingly ineffective and unstable. As the result of partial deregulation, the nature and level of competition in transportation greatly changed and, as such, exerted pressure on the carriers to become more efficient and more customer-service oriented.

Though the effects on labor in both the trucking and railroad industries were dramatic, they were substantially different. In the case of trucking, the adjustment to the new economic realities took the form of wage-increase restraints and wage reductions with little effect on overall level of employment. The employment level in the trucking industry has increased although union membership has declined substantially. Data indicates that more than 100,000 Teamsters have lost their jobs since 1980, and that since deregulation union premia over non-union wages have fallen from 50 percent to less than 30 percent. Trucking labor costs as a percentage of total operating revenues decreased from 50 percent in 1980 to 46 percent in 1986.

The impact of regulatory reforms on rail labor took a different form. Instead of wage adjusting, or price adjusting, quantity adjusting took place. Since 1980 Class I carriers have reduced their employment levels by almost 200,000 representing a reduction of more than 40 percent. Overall, the rail employment levels have been reduced by about 30 percent since 1980. To be accurate, one must note that other long-term economic and technological forces have been operating to reduce the demand for labor, but deregulation definitely has had an impact on the rate of adjustment. In terms of relative wages, i.e., the average wage of one industry compared with the average wage level for all non-farm industries, the rail industry has seen an increase of more than 10 percent since 1980 while the trucking industry has witnessed a decline of more than eight percent. Rail labor costs as a percentage of total operating revenues were the same in 1980 as they were in 1986—52 percent.

Changing Rail Labor/ Management Relations

Beyond these general trends, deregulation has altered the environment of labor/management relations in the rail and other transport industries. As noted, most transport labor markets are more highly unionized than the typical labor market in America. For example, while 61 percent of the blue collar workers in transportation, communications, and public utilities are represented by a union, only 30 percent of all United States blue-collar workers are unionized. Transport labor markets tend to be more highly unionized than even the manufacturing labor markets. With the relatively high unionization rates, transport leaders often have tried and have been successful in establishing a uniform, industry-wide basic minimum standard for compensation and work rules.

Transportation firms have adopted a variety of labor management strategies to cope with the competitive pressures brought about by deregulation. The most prominent of the rail industry strategies in the labor/management area are the following:

Establishment of Non-union Subsidiary

In the motor carrier industry, the establishment of "dual companies" proliferated to the point that one of the major goals of the Teamsters in their 1985 and 1988 national labor contract negotiations was the stopping or at least the slowing of the further creation of such non-union trucking operations. In the railroad industry only two carriers have attempted to establish subsidiaries which employ non-union workers or utilize different work rules. The strategy has been constrained by legal rulings. In June, 1988, a federal court ruled that the Burlington Northern must negotiate an agreement on crew consist with its unions before starting operations of its wholly-owned subsidiary, the Winona Bridge Railway Company. In the same month, an ICC-appointed labor arbitrator ruled that Guilford Transportation Industries, Incorporated, must reinstate the labor agreements which existed at the main line railroad companies which were transferred to a non-union subsidiary, the Springfield Terminal Railway Company.

Selling of Short Lines

A different but related strategy used by the rail industry that affects rail labor/management relations is the divestiture of unprofitable or marginally profitable rail lines to newly-created regional, or short line, railroads. More than 190 spin-off railroads have been formed through the sale of track since 1980. Since 1982, the ICC has routinely been refusing to order labor protective conditions on line sales by larger railroads to regional carriers. The ICC ruled in 1985 that regional rail spin-offs were not merger transactions within the industry and, thus, the harsh labor protection provisions did not apply. In addition, the ICC ruled that the new owners of the regional lines were not operating railroads and thus were not obligated to hire workers previously employed by the line or to abide by existing labor contracts.

In many ways, these regional lines can serve the same function for the rail industries as the "double breasting" operations do for the trucking industry. The October, 1987, Burlington Northern sale and lease of some 800 miles to Montana Rail Link is an example where the relationship between the Class I carrier and the newly formed line is not independent but yet not a subsidiary.

A November, 1987, district court decision, upheld by the Court of Appeals in April, 1988, has virtually put a stop to this option by saying the Railway Labor Act supersedes the Interstate Commerce Act in matters involving employees. In short, negotiations between labor and management must occur before the line sales are allowed to proceed. On the other hand, another Court of Appeals ruled that the unions could not strike over the decision by the Chicago and North Western to sell its Duck Creek South Line to a regional operator. It is clear that the United States Supreme Court will be needed to provide a clear signal in this matter.

Outsourcing

Outsourcing, which is the contracting out of service or work typically performed by the carrier's employees, is a relatively new strategy that has the potential of greatly changing the rail labor/management relations. The Burlington Northern's recent decision to contract out part of its locomotive maintenance not only illustrates the concept but also the strong union reaction that will likely result if other carriers follow this strategy. The unions wanted negotiations on this issue and threatened self-help actions when the Burlington Northern refused. This option has been placed effectively on hold with a court injunction still pending that prevents self-help actions by the unions and further outsourcing by the Burlington Northern.

Less Emphasis on Industry-wide Negotiations

Though many exceptions can be found, traditionally, the means of setting industry-wide wages, benefits and work rules has been through "national handling". In the current environment, major carriers, such as the Burlington Northern Railroad, CSX and the Chicago and North Western, have decided to negotiate separately with the unions. This stance has caused some confusion among the unions on how to proceed and has created substantial concern among railroad management. A large number of on-going negotiations will possibly extend the bargaining process which is already too long. In addition, the concern exists that the early agreements might set a precedent for later negotiations or establish guidelines for arbitrators or Congress to follow. Despite these potential problems, I would argue that this move toward individual bargaining is consistent with the policy of deregulation under the Staggers Act that encouraged individual actions by carriers.

Changes in the Rail/Truck Competitive Environment

An analysis of the changing rail/truck competitive environment which uses aggregate market share data would incorrectly indicate that not much has changed in the competitive relationship between truck and rail. Since 1980, rail and truck market shares in terms of ton miles have remained relatively stable—about 36 percent and 24 percent respectively. In terms of tons, rail and trucking have maintained market shares since 1980 of about 27 percent and 15 percent respectively. The changing nature of the competitive environment involving railroads and trucking becomes more evident when one examines the market shares in terms of revenue. Rail revenue, as a percent of all freight revenue has decreased from about 13 percent in 1980 to only 10 percent in 1986. In contrast, trucking revenues increased from about 72 percent to 75 percent during the same time period.

The fluid, dynamic market situation of the rail industry is illustrated by the fact that rail tonnage has declined by 13 percent since 1980, and that figure would increase to 19 percent if coal tonnage is excluded from analysis. The competitiveness of the trucking industry is also clearly shown by the fact that the railroad industry has increasingly become focused on bulk commodities—commodities not well suited for trucking. Today, nearly 50 percent of the rail industry's revenues and about 65 percent of its tonnage are generated by four commodities—coal, farm products, minerals, and chemicals. In order to gain market share back on non-bulk commodity groups, the rail industry must meet the service and rate offerings of the segment of the trucking industry that provides competition for railroads—the truckload sector.

A number of factors, both internal and external to the trucking industry, have increased the competitiveness of the truckload sector of the trucking industry.

First, manufacturing firms, in an attempt to reduce inventory costs and become competitive in the global economy, have adopted just-in-time production techniques, which favor the truckload carriers. The technology associated with trucking allows smaller, more frequent shipments which are required by small-batch manufacturing. The "Transportation Journal" reported in its Spring, 1988, issue the results of a survey on the impacts of just-in-time on corporate transportation purchase decisions. Yes, the rail industry was the big loser.

A second factor is the productivity increases allowed by the Surface Transportation Assistance Act of 1982 that have greatly increased the competitiveness of the truckload and LTL carriers. Between 1982 and 1986, the larger 48-foot trailer went from two percent of the rail-competitive intercity truck fleet to more than 60 percent. These productivity gains appear to have produced benefits for the trucking industry that are greater than the costs associated with the tax increases of the same 1982 act. A third factor, and the most significant factor, is the partial deregulation of trucking enacted by the Motor Carrier Act in 1980. Substantially more price competition was allowed and encouraged in the Motor Carrier Act of 1980. The virtual elimination of entry standards, both for firms trying to get into the industry and for existing firms trying to expand into new markets, has had the greatest impact on the efficiencies of the trucking industry. In my opinion, the provisions of the Motor Carrier Act which deregulated entry into the industry and new markets were the most important in terms of having long-run effects on the amount of competition between rail and motor carriers.

The total number of ICC-regulated carriers increased from about 18,000 in 1980 to almost 40,000 in 1987 with most of these being smaller truckload carriers. Virtually all of these were non-unionized carriers. The impact of entry of non-union carriers is reflected in the statistics that show the percentage of all intercity drivers that belonged to unions dropped from about 20 percent in 1980 to about five percent in 1986. Regulatory reform measures also allowed the expansion and more efficient use of private carriers in the trucking industry — carriers that are very effective competitors for railroads in many markets.

The important question is: what changes have these factors, and others, made on the competitive interface between the trucking and rail industries? They have allowed and encouraged and forced motor carriers, particularly rail-competitive truckload carriers, to be more cost effective and responsive to the shippers' needs. For example, (1) both real costs and real freight revenues have fallen in the truckload sector since 1980. Professor McMullen of Oregon State calculated that the average costs adjusted for inflation for truckload carriers have fallen by approximately one-third and the inflation-adjusted truckload freight revenues per mile have declined almost as much. Another study indicated that the real truckload rates in 1986 were 18.5 percent below 1980's level. (2) The competitive environment created by the Motor Carrier Act (and the Staggers Rail Act of 1980) has fostered the development of a special group of truckload carriers—Advanced Truckload Firms. These carriers utilize 24-hour, seven-day-a-week dispatching, the larger trailers allowed by the 1982 Surface Transportation Assistance Act, and multiple pickups and deliveries. Along with improved service, these carriers, such as J. B. Hunt, have lower costs than normal truckload carriers. In 1986 the typical Advanced Truckload Firm's long run marginal cost was 12 percent less than the costs incurred by normal truckload carriers. Greater utilization of the vehicles per year and the concentration of their hauls along heavy density traffic lanes create these efficiencies.

The increased price competition from the low-cost, non-unionized carriers, many of which were new to the industry, forced the existing carriers, particularly unionized carriers, to adjust costs. Labor, which represents trucking's largest expense, has been the focus of these cost adjustments.

A variety of strategies has been used by truckload carriers to reduce their labor costs, including using employee stock option plans, to reduce direct wage outlays, breaking the National Master Freight Agreement, establishing non-union subsidiaries, employing two-tier wage structures, and increasing their use of owner operators. These strategies tend to make the necessary adjustment on the price side, that is, the wage level, instead of the quantity side, that is, the level of employment. The results have been significant. Since 1979 truck drivers' wages have risen just over 20 percent while wages for all other occupations have increased almost 50 percent. One study indicated that motor carrier real wages have declined since 1977 by 22 to 24 percent. The differences in total compensation between the truckload carrier employees and railroad employees are substantial. The average annual compensation for rail labor was $46,500 in 1985. In the same year, the average annual compensation was $34,000 for the Advanced Truckload Firm and $26,000 for the typical truckload carrier.

Final Observations

So, have the changes in rail labor/management relations kept pace with the changes in the rail/truck competitive environment? The answer is no. Despite significant efforts on the part of railroad management, the market pressures and forces in the output market are keeping ahead of the necessary changes in the labor/management relations. The demands of the unions do not appear to be consistent with the economic realities as they pertain to the markets in which railroads and trucking firms compete. Although the driver shortage, which is a truckload carrier problem, will tend to increase trucking costs, the strong competitive pressures from the truckload carriers will remain. Why aren't the rail labor/management relations keeping pace with the new realities in the transportation marketplace? I have several hypotheses: first, unlike the situation in the trucking industry, industry-wide profits have increased in the rail industry since deregulation. Union compensation demands are often linked to an industry's so-called "ability to pay".

Second, the railroad industry, under the Railway Labor Act of 1926, operates in a "mature" collective bargaining environment that includes numerous regulations and norms. The process required by the Railway Labor Act is not conducive for rational economic solutions that are timely. The recent Chicago and North Western/United Transportation Union labor/management agreement with respect to crew consist was neither timely nor based on economic grounds. In addition, rail labor has several additional weapons in its arsenal such as secondary picketing that trucking unions do not have. Moreover, other pieces of legislation have provided a statutory or case law support for labor protection that trucking unions (primarily the Teamsters) never had. Several strategies by rail management to change the labor/management relations to accommodate the economic picture have been struck down on the basis that the Railway Labor Act of 1926 supersedes the Interstate Commerce Act in issues involving rail labor. Furthermore, railroad labor is treated differently under federal law with respect to workmen's compensation and retirement systems.

Third, unlike trucking, new entry into the rail industry by non-union carriers is not feasible given the nature of the technology involved. The creation of subsidiaries, like the Winona Bridge Line, and the selling of lines to non-union regional carriers, tend to have the same effect as new entry. But, as noted, these options have been put on hold by court decisions.

So what we have is a somewhat peculiar situation. For many years the railroads were at a competitive disadvantage because of the more restrictive regulations they had on how they could provide and price their services. Now, in the area of rail-truck competition, both modes have substantial economic, commercial freedom on how to provide and price transportation services. For example, most of the truck competitive traffic moved by rail is done either in boxcars or in intermodal containers—both of which have been deregulated for several years. In February of this year, the ICC moved to deregulate rail hauls of most manufactured goods—one of the more important commodities that the railroads need to regain some of the high revenue traffic from trucking.

But, now railroads have a disadvantage relative to trucking in terms of their ability to effectively utilize one of their most important inputs—labor. A significant, if not the most significant, reason for this disadvantage is due to the unfair regulation of the railroads in the rail labor/management relations area. Congress needs to look closely at the 1926 Railway Labor Act to see if it should be changed or eliminated. Congress took action in 1980 to make the railroads more like other commercial enterprises. It now needs to complete the process by eliminating or changing the Railway Labor Act of 1926. Thank you. (Applause)

Mr. Fuller: Thank you very much, Dr. Allen. That was a very fine and interesting presentation.

At this time we will adjourn for lunch and meet back here at 1:30 p.m.

Adjourn

MONDAY AFTERNOON SESSION

September 19, 1988

D. J. Lewis

President Lewis: I hereby bring the 93rd Annual Conference of the American Railway Bridge and Building Association to order. On behalf of the Association officers and myself I wish to extend a warm welcome to all members, guests and friends. As of noon we had a registration of 119 B&B; 150 Roadmasters; 151 Associates; 70 guests, and 62 ladies, for a total of 552.

PRESIDENT'S ADDRESS

Several years ago the Association began its ''Get Involved'' theme and, as expected, participation was high at that time. Over the past years this participation has been diminishing slightly. Possibly part of this diminishing participation is due to some of the early retirements or the downsizing of some of the larger railroads. Individuals who were caught up in this downsizing may have joined other associations such as the American Short Line Railroad Association or even regional associations such as the New York Club, or Maintenance of Way Club of Chicago, or the St. Louis Railway Club. These are all good organizations but we should try to promote joint participation and membership. Our Association does not want to lose these individuals who may have helpful information related to some of our special subjects. They, in turn, may also be aware of information that these other associations may have, and to which we do not have access.

Several years ago an individual talked to me about the reduced membership, and when I say reduced, it isn't that low, but it fluctuates. We have been holding fairly consistent, but during the year it fluctuates back and forth. He asked me how I or other railroad people could increase the membership in the Bridge and Building Association. At that time, I really didn't have an answer for him other than by word of mouth, and since my exposure to a lot of the people is somewhat restricted, I then thought that maybe the suppliers who have a much broader source for contacts, could also speak in favor of joining the Association. They have contact with Class I railroads, short lines, regionals, metropolitan railroads, separate consultants, contractors, all sources like that all over the United States and Canada. I am not really implying that during meetings with these other individuals they should promote the Association, but maybe over lunch or dinner a few words definitely wouldn't hurt.

Something else that is part of this ''Get Involved'' theme is on the chairs. As you came in you found the yellow cards that have our 1989 special subjects. Please take one of these cards and fill it out. There are boxes on the back table for you to put them in. Even better, take some additional ones. Someone back in your company may have some information on one of these topics that we could use. This is how you can get involved. We did this a few years ago, and the responses were very good. The last couple of years we just laid the cards out, and the participation went down.

At this time I will introduce Tom Parker, who is the sponsor of our first special subject. Tom.

Mr. Parker: Thank you, Don. At this time I would like to introduce an associate and good friend, Mr. John Smith, of the Illinois Central Railroad who will present Special Subject No. 1 — Masonry Repairs to Buildings and Shops. As some of you know, John has been a member and active participant in our association for some time. John's background in engineering includes a Bachelor of Science degree in architectural engineering and post graduate studies in environmental science and structures. John has been employed by the Illinois Central Railroad for approximately 19 years and currently holds the position of engineer of buildings and facilities. Besides being a member of our association, John is also a member of the American Railway Engineering Association, Association of Military Engineers, and is an active member of the Army Reserve Corps of Engineers, having served recently in Honduras. Last, but not least, John is a licensed professional engineer. Please welcome Mr. Smith.

SPECIAL SUBJECT NO. 1

Masonry Repairs to Railroad Buildings and Shops

Chairman:	J. H. Smith, Engr.Bldgs.& Fac., IC, Chicago IL
Vice Chairman:	T. J. Gallagher, Pres., Kaufmann-Gallagher, Evergreen Park IL
Committee:	J. L. Neece, Supv.of B&B, CSX, Helena AL T. J. Parker, Proj.Mgr., Envirodyne Engineers, Chicago IL T. A. Wiedner, Pres., Weidner Williams, Omaha NE

Today's presentation will address the deterioration of various types of masonry and the procedures for repair and preservation. Guidelines for restoration of your masonry structures will also be reviewed.

Causes of Deterioration

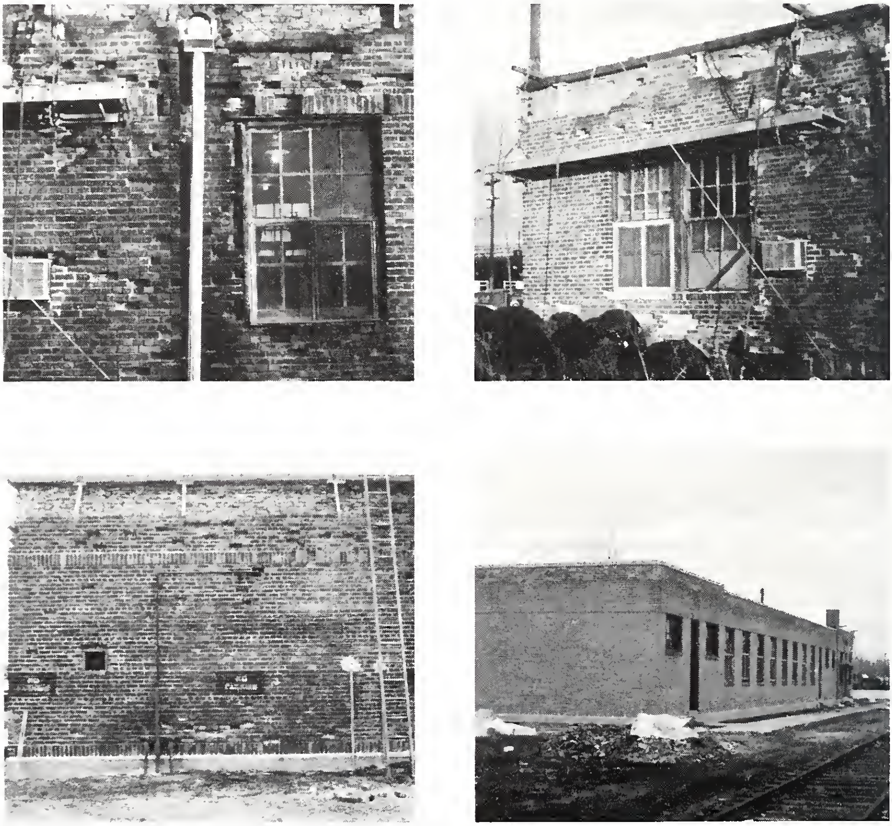
First, there are a number of ways masonry deteriorates. The best known is the freeze/thaw cycle period. For years it has been assumed that the pores of the masonry filled with water and, as this water froze, expansion of the ice would, therefore, fracture or spall masonry surfaces. Today, we are not so sure this is the cause.

Present day theory, backed by limited research, appears to point out that as the freezing takes place the pore is coated, not filled, with ice. The process reduces the surface of the pore, increasing capillary action ten or maybe one hundred fold. Experts now believe that the water to ice relationship does cause masonry fracturing.

Another familiar process of masonry deterioration is thermal expansion and contraction. All buildings expand and contract with larger structures requiring compensation in the form of expansion. This movement of masonry was traditionally accommodated by various construction techniques, including the use of "flexible" lime mortar. Lime mortar has no cement which makes it more "buttery". It absorbs moisture like limestone, swells and becomes impervious a short distance past the point of absorption. In post-1900 masonry construction, expansion and control joints are most commonly used.

On a much smaller scale, minerals within the masonry unit may move differently causing

Memphis Roundhouse



Hazel Crest Wash House

microscopic cracks, which speeds up deterioration. When the surface is wet, forces can also occur because of differential forces on the pore structure of the stone or brick masonry. This would be particularly significant if the stone or brick were sealed or painted. In either case, the greatest effect would be on the masonry unit surface that has been mechanically tooled or abrasive blasted, resulting in microscopic surface cracks.

A third source of physical deterioration is constant wetting and drying. This creates deterioration due to the capillary forces that can approach the tensile strength of the masonry unit. Since the capillary forces are in the hundreds of pounds per square inch, this constant wetting and drying can be viewed as applying and removing force. Highly absorbent brick on hot dry days, drenched with a sudden heavy rain storm, will expand dramatically and fracture brick units.

The final process of the physical deterioration of masonry is salt crystallization. A salt here is identified as a chemical compound that has an affinity for water. This salt that you may be experiencing on the surface of masonry units is efflorescence. Efflorescence appears as a result of the interior salts being dissolved because of moisture infiltration of the masonry unit. These salts are forced to the masonry surface by the natural forces of evaporation. As you know, this is unsightly but not particularly harmful. Ultimately, this efflorescence leads to crumbling or spalling due to a bursting force called subflorescence. Subflorescence is most likely to occur under a coating such as paint in an area of the wall subject to heat and natural forces of evaporation.

The logical question, then, is where do these salts come from? They can come from the masonry unit or mortar, from adjacent street salting, from fertilizer or even from water used to sprinkle plants or shrubs next to the walls, but mostly from the brick and mortar itself. Keep in mind the important thing here is to recollect that when efflorescence appears, something must be done. This can include roof repairs, new caulking, foundation repairs or tuckpointing, but usually application of water repellent is not sufficient to solve the problem.

In addition to the physical processes of deterioration, there are also chemical and biological processes of deterioration. Chemical processes of deterioration have received much attention lately due to acid rain. In fact, the source of the chemicals that weather and deteriorate stone is usually rainwater. The earth's atmosphere, even before man, contained carbon dioxide. Carbon dioxide dissolves readily in water, yielding carbonic acid. Industrial environments and downwind from industrial centers, sulfuric dioxide, sulfur trioxide, and oxygen of nitrogen are present; thus, the rainwater (acid rain) will also contain sulfuric and nitric acid.

All masonry materials are either acid soluble or acid insoluble. The acid insoluble materials are not affected by acid rain and include granite, most sandstone, most brick, most terra cotta, and most cement products. The acid soluble materials that we are concerned with here are the carbonates. This includes limestone, marble, travestine, lime mortar, some sandstone, some brick, and some cement products.

Calcium carbonate, which is the basic mineral in these acid soluble materials, reacts with the sulfuric acid and rainwater to yield gypsum and carbon dioxide gas. Subsequent rains then dissolve the gypsum, which is water soluble, and the stone begins to flush off the surface. This is why limestone and marble buildings can be so heavily streaked. Where rain cannot reach the masonry, sulfuric dioxide in the air reacts with condensation in the stone to cause the same deterioration of physical properties at the same rate as if the rain had reached the surface. The famous Greek Parthenon is an excellent example of this kind of deterioration.

In areas of the country where there are prolonged periods of drought, the occasional rain penetrates into the masonry about one inch to one and a half inches. Calcium carbonate from the depleted zone will then be converted into gypsum and brought to the surface. But, in the absence of a subsequent rain, carbon dioxide from the air will reverse the reaction in the weathering zone, returning the material to calcium carbonate. Over time a hollow spot develops in the depleted zone until the weathering zone breaks away and falls from the wall.

A third set of deterioration processes are biological. These are mostly chemical in nature, but they are separated out because they have plant or animal origins. To understand these processes, it is helpful to understand how some of these organisms originate. Algae, lichens, and fungi need continual moisture to survive. Mosses can develop in an intermittently wet area and then act to keep the masonry continually wet by their ability to hold moisture. They can then permit the growth of algae, lichens and fungi. These, plus ivy, all lower the masonry temperature by shielding it from the sun. Wind is also kept from the masonry and slows evaporation and accelerates all the moisture related physical and chemical processes of deterioration. Ivy also hides the masonry from visual inspection, and the vines can mechanically open joints.

In addition to these, shrubs and trees too close to the masonry will cause uplift pressure, or alternately, trees and shrubs can take so much moisture from the soil that subsidence causes the footings to slip.

Restoration (temporary reversal of these processes) or preservation (slowing or temporarily stopping these processes) can be accomplished, but some basic guidelines must first be understood. Buildings deteriorate logarithmically over time.

Generally speaking, the deterioration could be interchanged with cost. Each building experiences a certain degree of deterioration, but what that degree of deterioration is varies widely from a railroad's investment. A well maintained building, of course, will experience a greater investment. A poorly maintained building will experience less attention and be more costly in the long run. Since deterioration represents expenditures, railroads should plan as much as five years ahead as to what roles their masonry structures will play in the overall scheme of operations and plan restoration work accordingly. In fact, due to current tax laws and possible historic preservation efforts, many older buildings have a history of major deterioration. In correcting deterioration in a masonry building there are several stages or levels of intervention.

Cleaning

The least stage or level of intervention is the cleaning process. Cleaning a structure serves several functions: (1) it improves the appearance; (2) it makes minor physical defects such as cracks, spalls, and crude repairs visible; (3) since dirt entraps moisture, cleaning will impede the amount and period of contact with the masonry surface. In some severe cases, cleaning may even remove a vapor barrier of dirt that has formed on a masonry structure. The cleaning process can be combined with on-site inspections exposing the level of actual deterioration in the masonry, thus allowing for future planning for budgetary needs. Cleaning in any event is a preservative first approach adding to the extended life of any masonry structure.

Types of cleaning are:

1. Water mist method
2. Steam cleaning
3. Chemical cleaning tailored to the level and degree of dirt removal
4. Muriatic acid and water and hydrofluoric acid methods
5. Sandblasting method

The water mist method of cleaning is the least desirable level of intervention. This method dissolves gypsum. A gypsum crust often forms on limestone and marble, and a mist of water generally will flush or remove the crust. Problems with this method are weather limitations throughout the season with freeze/thaw cycles and only a fair job is really accomplished.

The second method is steam cleaning without chemicals. This method, however, does not usually perform well on old structures not having been cleaned for years.

Third is the chemical cleaning process utilizing various types of chemicals prepared specifically for masonry. This method is rapidly becoming the number one method, most popular, and most economical.

Our fourth method is the application of muriatic acid and water or hydrofluoric acid treatment. This particular method offers an advantage of chemical cleaning with market proprietary materials. It does, however, increase the risk of chemical etching or bleaching the masonry. Windows and other delicate and/or sensitive surfaces must be protected using as a minimum, parafin wax coating.

Last is the abrasive method of sandblasting. This method must be a controlled method due to the increased incidence of damage to the old structures and new alike. Probable damage may be: (1) masonry fractures creating minute cracks that may fill with dirt and water subject to freeze/thaw and wet/dry cycles; (2) creates a more porous skin or outer coating on the masonry units, rough style terra cotta, concrete, or limestone also subjected to the freeze/thaw and wet/dry cycles; (3) permits the buildings to soil faster; (4) creates dust and dirt over a wide area which may cause potential problems to building associated mechanical equipment; (5) changes the color of masonry; (6) may remove ornamental masonry motifs; and (7) also changes the masonry surface texture. However, in spite of the above, there are some projects where sandblasting is highly recommended. Removing paint from the masonry surface is readily done with sandblasting technique. In these cases, glass beads or black beauty slag is recommended.

Waterproofing

The next level of intervention is physical waterproofing, which includes pointing of masonry and caulking. In joint preservation, old mortar, should be cut out to a minimum depth of three-quarters inch to insure an adequate bond. For joints cut out to a minimum depth of one inch to insure an adequate bond. For joints less than three-eighths inch thick, cutting mortar back one-half inch is usually sufficient. In any event, loose or disintegrated mortar beyond this depth should be removed completely. Hand methods, should be used exclusively where damage to the masonry, especially "head joints", may result due to use of power tools. Small grinders and power tools such as chisels will speed the work up and lower the cost, and their use should be a strong consideration in the early planning stages of your masonry project.

In building preservation, masonry mortar that is one bag hydrated lime, one-fourth bag Portland cement and three cubic feet of mason's sand shall be used where the original mortar was nearly all lime and sand. Where the mortar combined Portland cement, a bag mix of one to one and one-half bags of hydrated lime, one bag of Portland cement and five to six and one-half cubic feet of mason's sand is recommended in areas of severe exposures such as in the upper midwest and in the southern climates. Keep in mind, of course, that the specifier should be guided by the general thought at some point in time, no matter how well specified or installed the mortar is, a portion of the masonry structure will again deteriorate, and when it does the masonry of brick, terra cotta or granite may become irreplaceable. So mortars should be weaker than the surrounding masonry and usually no stronger than the original. Use of caulking should be limited to control joints and windows and doors. Caulking anything else may entrap water and moisture and cause deterioration due to freezing and thawing.

The third level of intervention is chemical waterproofing. This method is the application of a clear water repellent to masonry to stop the penetration and resultant damage to the unit caused by rain. These materials are designed to breathe while repelling water and contain several different resins including silicone and the new xylenes. It is suggested that you consult the manufacturer for a type silicone that would best suit your masonry needs since research testing throughout the industry has tested various types of silicone under varying conditions. Why? Because in old buildings masonry was set in sand and lime and water generally didn't exceed one-half inch penetration due to lime swelling and acting as a waterproofer.

Thicker masonry wall sections, as in old historic buildings, take less time to dry out than modern masonry. A leaky wall may be saturated and the repellent may accelerate damage. Efflorescence may be eliminated by the use of waterproofing, but it may be replaced by subflorescence which is potentially much more damaging. Keep in mind some railroad structures have been around since the turn of the century without leaking. You would think, "If tuckpointed, why should it leak now?" If waterproofing protection is desired nonetheless, investigate the various types of waterproofing materials since they have been proven to be very effective in reducing freeze/thaw and wet/dry cycle damage without causing subflorescence.

On masonry surfaces that have weathered away it is not recommended to use a clear water repellent. Keep in mind that hairlines cracks, a major source of moisture infiltrations, cannot be sealed by a proprietary liquid such as silicans as reported by U. S. Government testing.

Masonry Patching or Repairing

The fourth level of intervention is masonry patching or repair. These methods usually involve the use of substrate materials such as Portland cement and sand. Keep in mind that there are two points to be aware of when patching a deteriorated masonry surface. The first is that color pigments will fade. It is suggested that whenever possible, the color of the patch should be achieved by mixing Portland cement and various colors of natural sand to duplicate color. Variations of color can be achieved by interchanging of Portland cement brands or sources of sand. If color pigments are used, a slightly darker color than the surrounding masonry is desirable so that as it fades it will more closely approximate the color of the masonry. However, this is time consuming and very costly.

Larger patches are commonly keyed in by a dovetailing process using anchors. Stainless steel, wire mesh and stainless steel nails are recommended since rusting is a great concern of any patchwork. Smaller patches can be keyed in by using a standard three-eighths inch masonry drill bit and boring into a sound substrate. By this type of installation the patch cannot come straight out. A latex or epoxy bonding agent should be used. The latex should be non-dissolving and non-water soluble. Without super adhesion the patch will fail.

The fifth and final level of intervention is replacement. This method can be easily done by matching the existing masonry, substituting closely modern materials for old ones. Fortunately, terra cotta is again in production, and the art of making mods has not been lost. However, it has been the experience of some railroads to artfully replace terra cotta with limestone, lightweight epoxy or concrete at a lower cost.

Conclusion

The existing conditions and suggested solutions should provide you useful tools for the evaluation and inspection of railroad masonry. In all, our railroad infrastructures require an on-going maintenance program with management commitment. This reminds me of the Fram Filter commercial, ''You can pay me now or pay me later.''

Thank you. (Applause)

Mr. Burns: Does anyone have any questions for John?

Member: I have some old roundhouse structures where the masonry walls are actually falling away from each other, have you done any pining on those walls or any type of repair work covering that, or have you written that off as a loss and looked at replacing the building?

Mr. Smith: I wouldn't write that off as a loss. Depending upon how you can brace it how important that facility is, if it is one that you want to maintain over time, certainly you might want to reinforce it. I have had experience where we have had bowing and we have installed steel beams vertically on both sides and pulled them together. That has been my experience in that particular area. There may be some others out here in the audience who have tried something a little differently. But we had bowing, and we literally just pulled it back together by using steel I-beams on both sides. We found that to be the most cost effective. Any other questions? Thank you very much.

Mr. Burns: Thank you, John. Today, as always, engineering and maintenance personnel are asked to find innovative methods of installing structures which are economical and will cause the least disruption to railway traffic. Our next speaker, Mr. Anthony Lynn, will present a method of installing large concrete boxes in existing enbankments.

Mr. Lynn has been in the tunneling and jacking business since 1971. He is currently the president of hiw own company, Quickbridge. Mr. Lynn.

BRIDGE JACKING

Anthony Lynn
Quickbridge

My thanks to the members of the American Railway Bridge and Building Association for the opportunity to address you today. I'm going to talk to you about bridge jacking. Bridge jacking is an outgrowth of box jacking which is an outgrowth of pipe jacking, so let's start there.

Pipe Jacking

Here are some slides from a rather typical pipe jacking job we completed beneath the Garden Grove Freeway in Los Angeles. This job involved pushing 240 feet of ten foot inside diameter pipe through a silty sand. The 12 foot long pipe sections were pushed from a jacking pit containing four 250-ton, 13 foot stroke rams. A chain of modular conveyers transported the excavated material from the front of the tunnel to the jacking pit and beyond to the muck pile. In the front of the trench a heavy steel tunnel shield cut the earth like a giant cookie cutter. Within the shield a mining machine with twin counter-rotating augers loosened the earth and moved it to the first conveyer.

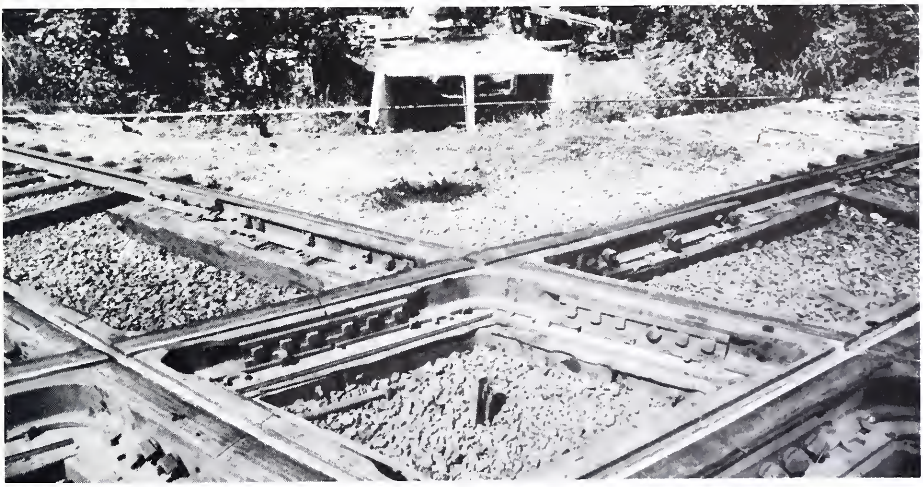
A laser beam provided a straight line reference along which to "fly" the tunnel shield. The shield was steered by hydraulic cylinders in the shield that reacted against the first pipe.

Absolutely critical to the success of a pipe jacking operation in sand is successful lubrication of the outside surface of the moving pipeline. Two elements are key: first, the lubricant must retain its lubricating properties and not be absorbed by either the pipe or the surrounding ground. Secondly, and most importantly, it must be completely and uniformly distributed.

In jacking the 240-foot length of ten foot inside diameter pipe, we found a very strong inverse correlation between required jacking forces and effectiveness of lubrication. For the whole 240 feet we managed to control line and grade to a three-quarter inch maximum deviation.

Box Jacking

A typical box jacking job was our jacking of a double 10 foot by 12 foot box 180 feet beneath the Pomona Freeway in Los Angeles. This job involved jacking a 90 foot long box section under the freeway, and then forming, pouring, and curing a second 90-foot section. During this period we continued to lube the first half to keep



View from Conrail and Chessie crossing looking at bridge before jacking begins.

Bridge in final position at end of jacking.

it free. After the concrete of the second box had reached 3,000 psi we began pushing the full 180 foot long structure. We used fourteen 150-ton rams for a total thrust capability of 2,100 tons.

Two tracked excavators operated in the two chambers of the box culvert. A 50 horsepower fan ventilated the boxes. Grade was controlled by an adjustable trimmer on the bottom edge of the steel shield.

The periphery was subdivided into small sections and equal volumes of lubricant were pumped to each section.

This box was approximately 23 feet wide. Cover between the top of the box and the roadway was only around ten feet. A recognized hazard in this kind of situation is carrying the overburden along with the box. As in pipe jacking, effective lubrication is the key to preventing this.

Bridge Jacking

In jacking the larger boxes it has become clear to us that we are pioneering jacking small bridges into place. This concept is best exemplified by a job we did for the city of Lawrenceberg, Indiana. They needed a two lane underpass to provide truck access beneath both the Conrail and Chessie railroads.

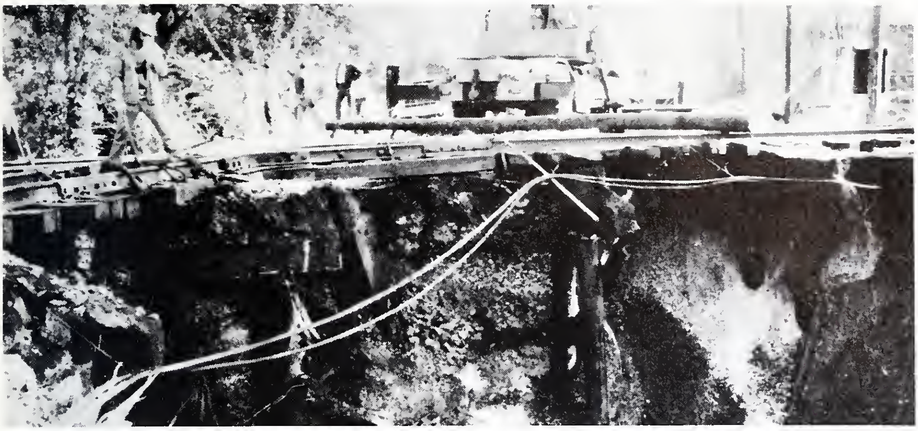
After studying the physical situation, train traffic patterns, and economics we decided to push the bridge in place in an open cut. We requested an eight hour window during which the tracks would be free of trains from both railroads. They responded initially by giving us a 24 hour window if we would push the box on Labor Day. We agreed, and subsequently, the railroads volunteered a 48 hour window over the Labor Day weekend.

We built the bridge on a concrete launch slab directly in line with the crossing of the two railroads. The bridge was built as a large box structure with integral wingwalls. As the last train passed we started jacking. A crane hooked to the track crossing held the rails up as the excavation advanced. We had not gone far before we were surprised to discover that the railroad embankment was actually an old trestle that had been buried. Tearing out the interfering pilings slowed us, but within about 12 hours, the bridge was in place. The next day we backfilled the sides and ballasted the top. Railroad crews fine tuned the track grade. No problems were experienced when trains rolled over the bridge the next morning.

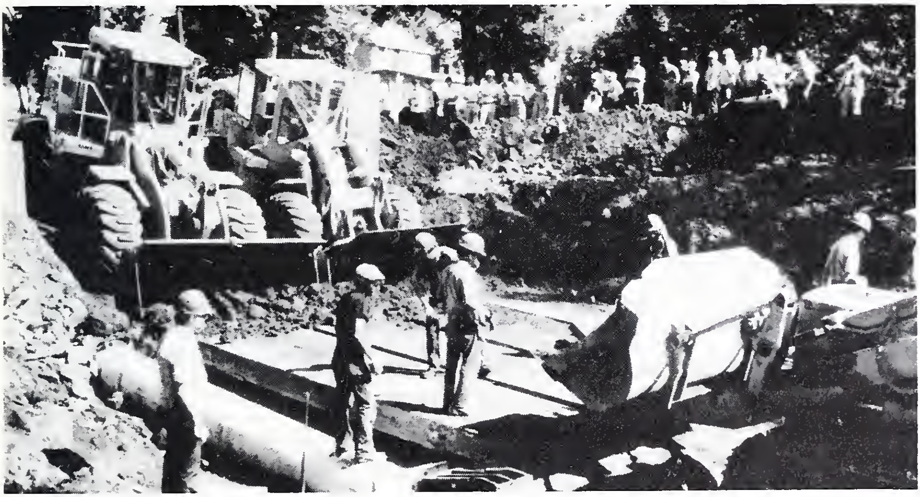
We feel that the bridge jacking technology has great potential. It allows 95 percent of the bridge construction process to be accomplished in a relaxed atmosphere away from the constraints of traffic. Only the actual bridge installation is conducted within the railroad zone of influence. During this brief window, traffic must be held or rerouted.

Our experience leads us to believe that two or four lane underpasses can be completely installed in eight to twelve hours. That is from the last train rolling across the embankment to the first train rolling across the bridge and the total elapsed time can be as little as eight to twelve hours. For a minimum time installation, the bridge would have steel cutting walls to cut through the embankment cleanly and obviate backfill. The railroad roadbed would also be prepositioned on the top of the box before jacking. Then, when the box reached final position, the tracks would be lowered onto the roadbed and fine adjusted.

The jacking approach offers the greatest savings in areas where shoofly construction is most difficult. We recently estimated a bridge replacement job beneath a busy commuter railroad in a congested metropolitan area. There



An old trestle was under the embankment. Note crane block in top of photo holding track crossing in place.



Box was pushed on Labor Day so many townsfolk came to watch. Loaders are pushing up run out deck after thrust pipes are extended.

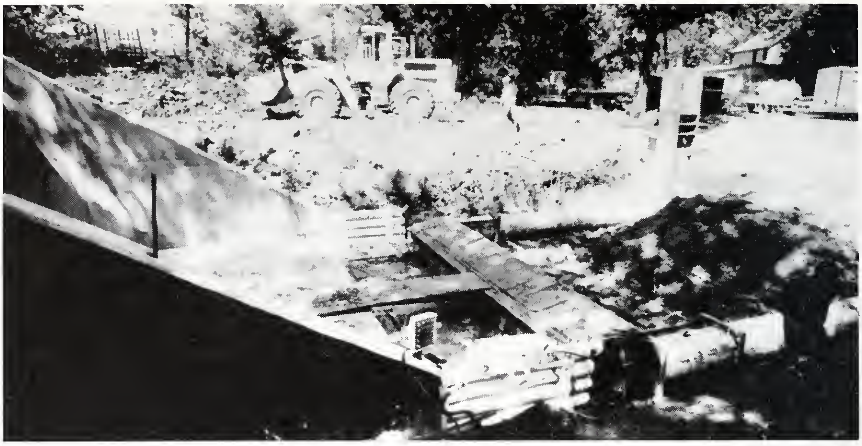
the jacking approach was approximately half the cost of the traditional shoofly method.

We believe that the jacking method need not be confined to small underpasses. We have also bid to jack a two-span bridge of 132 feet total overall width. This was a freeway underpass with two three-lane roadways passing beneath the tracks.

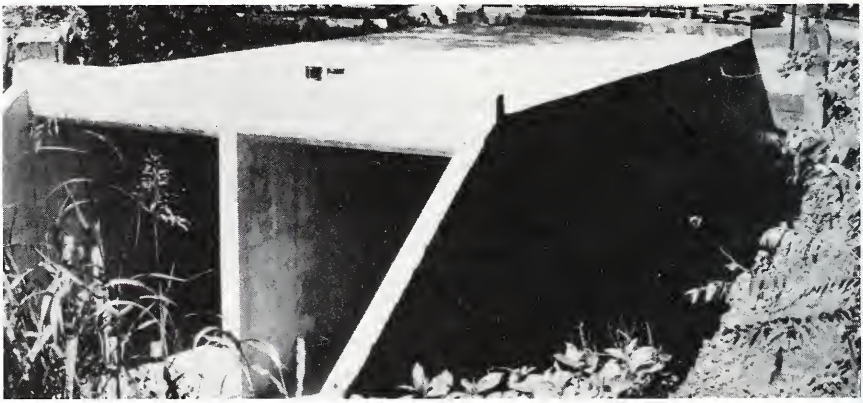
Essentially, if the designer of a bridge will imagine the several individual footings turned into one massive slab with a flat bottom, then he has a jackable structure. We urge all railroad engineers to further consider this approach. We would be pleased to consult with planners, construction people, and designers regarding specific projects. Are there any questions? If not, thank you very much. (Applause)

Mr. Burns: Thank you, Tony. That was very interesting. At this time we will take a ten minute break and will meet back here at 3:00 p.m.

Recess



1,000 psi 150 ton hydraulic cylinders pushed the bridge forward.



Bridge ready for jacking.

President Lewis: This session is now called back to order. Byron Burns will introduce our next special feature. Byron.

Mr. Burns: Thank you, Don. Our next speaker this afternoon is Mr. John Weber of New Jersey Transit Rail Operations. Mr. Weber received his Bachelor of Science and Master of Science degrees in industrial engineering from the University of Pittsburgh. He began his railroad career in 1964 with the Union Railroad and later worked for the Pittsburgh and Lake Erie. In 1971, he joined the staff of the Industrial Engineering Society and was responsible for the design and construction phases of the Society's relocation from New York to Atlanta. In 1973, Mr. Weber joined Rohr Industries, working in the areas of the Amtrak rehabilitation project, the bus assembly operation, and the transit car building operation. Beginning in 1977, he began working as a consultant on the Northeast Corridor Improvement project, with responsibilities in the design and construction of all maintenance facilities. Mr. Weber joined New Jersey Transit in 1982 as director of equipment and facility design, serving in that capacity until promoted to his current position of chief engineer civil in 1984. He is currently responsible for all capital construction, environmental engineering, and project management.

Mr. Weber is a member of the Institute of Industrial Engineers. He also serves as chairman of the sub-committee on yards and shops of the the American Public Transit Association and is vice chairman of sub-committee 3 of committee 12 of the American Railway Engineering Association. May I now present Mr. John Weber.

NEW JERSEY TRANSIT MEADOWS SHOP

John M. Weber

Chief Engineer Civil
New Jersey Transit Rail Operations

Background

Ladies and gentlemen. I would like to share with you one of our major construction projects. I will concentrate primarily on the foundation activities which were involved in that project. But as a way of general background, when New Jersey Transit was formed in 1983, it was as a result of taking over the commuter operations in the state of New Jersey from Conrail which had been the operator for the Department of Transportation since the demise of several northeastern railroads. As a result of taking over that commuter rail operation they were presented with a fairly nifty fleet of equipment, a pretty good sized rail facility, and the pits for maintenance facilities. We were operating out of 1903-type structures not capable of performing the work that needed to be done on any of the equipment.

So the decision to construct a maintenance facility was actually made before they took over the rail operations. This facility would serve the equipment fleet for all of New Jersey Transit connecting those lines formerly operated by the Pennsylvania, the Central New Jersey, known as the Newark Division and operating on the Northeast Corridor, the old Erie-Lackawanna, which concentrated on the Morristown Line and terminated in Hoboken. These two basic halves of the railroad had never really been joined very well. It was like an eight-hour operation to get a locomotive from one side of the railroad to the other. So we finally located this site and agreed to proceed with construction of a maintenance facility. The site had formerly been known as the engine facility where they had stored the locomotives for operations through the New York tunnel right in the Meadows area at Carney. We were able to purchase about 78 acres of that site from Conrail. It made us a rather unusual site. I think I really should put a slide up here, so you can get some idea of how it is now, and then we are going to go back a little ways when I start moving the slides.

Site Preparation

This is the Morrison-Essex line running up right along side of the building. The main shop complex itself is shown here in the foreground, and the various support yards are in the back. It's basically a triangular shaped site, and the Northeast Corridor crosses right underneath the New Jersey Turnpike bridge up there. It is a 78-acre site, and there are about 12 miles of railroad planted on it right now and about a half million square feet of shop buildings. One of the things that was significant was the fact that right here on the side, you'll see a big facility. That was a postal facility that had utilized basically the same foundation technique that we used for the major part of the building. Unfortunately, we were beset with many problems of a political nature as were were trying to build this on site, and the foundation area was just around the major shop itself. This separate building over here, which is our service and inspection building, was on-again, off-again during the time that we were designing the construction, and we had to just kind of push it away because it was too far out of the picture. That is built on the standard piling type structure. Also there is another small building up here that was a pre-service inspection building. Basically it is to keep all the dirt out of the shop. It is an old blow shed with eventually a paint shop addition to it, so we can keep all those nasty things away from the main shop itself and try to keep all the dirt out of there. Again, it was of such a small scale that to do any of the work that I am going to talk about in an area that small was something that was highly impractical, if not totally out of the question.

Now we step back in history. This is what the site looked like when we went down there and started demolishing things. The conditions were those of a very fouled site; poor drainage. These are some of the old buildings as we started demolishing them. This had been their locker room. That is probably the best building that was on the site. This had been an erecting shop that had served the former Pennsylvania Railroad until the early 1960s when they had no use for it.

This is why I talk about the drainage conditions. We had "Lake" Meadows when we first went out there. You can also see the remaining Conrail operation over here which is the famous Tropicana juice train, right off the edge of our property. Conrail consolidated their piggyback facilities in the South Carney area adjacent to the site.

At the time we started working there, the site was basically about five and one-half to six feet above sea level, so you don't have an awful lot of ways to make water move when you are that close to sea level. However, a part of the project included raising the site substantially, so that we could get out of this kind of drainage situation.

This is the beginning, where we started after making the conscious decision to perform an excavation, and I like to refer to it as the biggest swimming pool in the state of New Jersey. It was about an eight to ten acre hole that we excavated to remove what was know as the "meadow mat", so that we could recompact select fill in the hole and go to spread footings rather than piles. This decision was based on our geological survey that showed us that we were sitting on top of about ten feet of loose fill, five feet of this meadow mat, which is nothing more than a primeval cedar forest. In fact, we got some pretty good slabs of cedar out of the hole as we started the excavation. Immediately below the meadow mat were five feet of sand and 80 feet of varve clay. Basically this material provided something that had good compressive qualities; the shear qualities were terrible. I think I can best demonstrate that by when we did the pilings. When they were starting to drive the test piles, they had a sleeve pile that was a hundred feet long. The pile driving rig was capable of accepting that length of material. They had made a pre-bore down through the meadow mat, so they had gotten down about 15 feet through this tangle of roots, stumps, and trees. They set the pile up in the rig, and placed the hammer on top of the pile. It disappeared about 80 feet before they ever turned the pile driver on. It just kind of whooshed. And of course, in about three blows we hit bedrock down at 98 or 99 feet.

Basically what we have is a foundation on which we are capable of putting spread footings and using rather conventional construction techniques. The first thing that we had to do because of the low water table was to dig below the meadow mat and put an impermeable liner the whole way around the site. This enabled us to minimize the amount of dewatering that had to be done during the major part of the excavation.

The Excavation

Now we get into the area. The major portion of this excavation was adjacent to our main line on the Morrison-Essex line, and to protect the railroad we had to bring in a pile driving rig and put sheet piling right up against the railroad to make sure that we weren't going to lose the railroad while we were making this excavation. This shows you both the proximity of the railroad and the wonderful drainage conditions that we had to work with.

This is another shot of the railroad right behind the excavation. We went right in front of that sheet piling literally down 15 feet to make a shear excavation and refilling with clean select material. This is just kind of a look-see up along the side of the railroad where all of the sheet piling was used to make sure that we didn't lose the railroad into the hole.

Now the excavation itself begins. You can see the nature of the material that is coming out of there. We made test borings on this site and in spite of all the preliminary examinations we made, one of the surprises was two layers of abandoned railroad that had been filled over. We found all kinds of pile caps on subterranean foundations that had been abandoned. We ran into about 13,000 short wood piles that had been driven into this site that we had to excavate and dispose of. The bottom line of this was that instead of reusing 40 percent of the material, which going into the project we felt that we were going to be able to do, we had to find an off-site source, and we literally had to scrap everything that came out of this hole. Actually it turned out to be the equivalent of good top soil, and we had a couple of sanitary landfills that were being closed at the time, and the contractor was able to utilize this for top cover for those landfills and saved himself a lot of trucking. He could make a round trip with a truckload of this junk in about 15 minutes.

You can see here the tangle of the meadow mat on top of the sand layer. Here is one of the pieces of concrete we found under the ground. The piles don't show too clearly, but there is a tremendous number of short wood piles under there that just penetrated into the clay layer. That is where the piling for these old buildings ended.

This is another picture of our big swimming pool as we were making progress in getting the hole excavated. Again, here is a better picture of the meadow mat which really was the big problem in utilizing the site. That meadow mat could not be compacted. It was nothing but springy material and your choices were either to pile down through it or to remove it, and reconstitute the site. We had estimated going in with a $4 to $6 million savings in this eight acre building just by getting rid of the pile. Of course, knowing what we ran into after the fact, that was a very conservative estimate. We probably run into more like $8 or $10 million of extra cost.

Here is a big chunk of the concrete that came up out of that hole, just broken material that we had to get out of there; these were the sort of surprises we were faced with.

Dewatering and Backfill

This is a shot of some of the dewatering equipment. As you can imagine we had a lot of water to get out of that hole. Anytime we stopped working, even with the impermeable dike, we had extreme amounts of water that would get into the excavation, and so we had all this dewatering equipment. That is a shot of the backhoe and, in the very back part, one of the things that we were going to use. That is what we call a "Grizzly" for trying to remove the junk from the soil to reuse it. After about a day and a half of playing around with that thing we found out there was no way that we were going to salvage any significant amount of soil out of this hole. We abandoned the Grizzly and just proceeded with the backhoe and the normal dewatering. Now here we are getting into a little later time, as we are starting to re-backfill and putting in small lifts of earth and compacting it, so that we can get the proper compaction. We timed the thing so that we would have six months of surcharging with the entire amount of backfill material in addition to raising the site three feet. We had to do this, and thank goodness the local authorities were willing to work with us. We had anticipated getting up that far just to get the necessary yard geometry we wanted for safety. Had we had to meet the new flood plain we would have had to raise the whole site another six inches, which would have been pretty expensive. But as it was they allowed us to just raise our level the three feet that we needed to get the geometry. That put us at nine and a half feet above sea level, and they had established a new plain at ten feet. So technically if we get the 500 year storm it's going to be a wet little building that we built out there.

One of the things that we did with this backfilling was try to conserve some materials from the half million cubic yards of earth that we removed from this hole and replaced in areas where we knew we were going to eventually excavate for pits and depressed floor areas. We had the contractor who was doing this excavation and backfilling use subballast material for those areas where we knew we were going to be excavating. After the surcharging period was passed we then were able to have the building contractor remove that material for his pit configurations and to stockpile it for the grading and drainage utility contractor who was coming right behind him. He was able to use that as subballast material for building the railroad that went on the site.

Also, we put in a significant drainage system as you can imagine. That drainage system was basically there to facilitate construction. In other words, it was within the whole perimeter of the site. Inside that impermable dike we had put a significant drain system that could be used to keep the water out during construction, and, of course, is there for any of our future maintenance activities. If we should have to make any significant excavations during the life of the facility, we will be able to reactivate that drainage system to keep the bulk of the water away from us while we are working on the site.

The Structure Today

This is another aerial view of the facility as it turned out. It has given us the kind of facility that we need for the maintenance of a fairly significant rolling stock fleet. We have about 100 locomotives, about 400 self-propelled vehicles, and several hundred coaches that comprise our fleet. Some of our maintenance-of-way equipment is also maintained in this area. There is significant expansion area included. In other words, the hole that we excavated will allow us to fill in this portion of the building for future expansion. We can extend this area out another couple of car lengths to give ourselves pretty good expansion capabilities. Back in this area we have half of the yard area that was not built at the time which is capable of being expanded for the additional yard facility. This building was erected as a two track building. This is for the daily service and inspection of trains, where the full train can pull into the building and be worked on under close supervision. This is also sided in such a way that we can add a third track to that building. We can knock the one end out of the building and extend the length of it another three car lengths. The size trains we were operating with at the time we built the facility was seven cars with a locomotive. Our locomotive is capable of supporting a ten car train. That is why we have the three additional car lengths. We can pop this end of the building out and move another three car lengths to give it a full ten car train if we should decide to go to a ten car train. As I said, we have additional track space and can still put in the additional running tracks and have our various access roads available to get back through the site.

Right now the project is still going on. Unfortunately, we ran into a couple of defaulted contractors on the way to the finish of the project as well as some no-bid situations. We ended up no-bidding our paint shop, which goes right on the edge of this building, twice. We are now in the process of bidding it a third time. We seem to have some interest in it this time. I think one of the things that bidders didn't want was a small building like that with all this other major work going on. They just didn't want any part of it.

The other problem we have is right here. This little part sticking on this service inspection building is an indoor car wash. We had a car wash manufacturer who strung us along right up to the day he was supposed to install the thing and never performed. We finally had to default him. We currently have a new contractor underway, and he is busy at work trying to get us our car wash so, hopefully, next summer we will be able to wash these trains that we have down there. Right now we have to run them over to Hoboken which is our only car washer but at least we can do that now with this facility, because we have easy access both to the Northeast Corridor and to the Morrison-Essex line.

One of the other features of this facility was the keeping of the employees' vehicles and everything away from the facility. This is a top level walkway and elevator tower-stair tower where our employees can park with good access to the highways and then walk over. This runs the entire way from the main building across to the service inspection building, so these people can access their work sites without having to go across railroad tracks at grade level where they could get injured. Also, all of the welfare facilities are up on that upper level. That is one of the things we were able to do with this to beat some of the code brethern. We were going to have to do a lot of nifty things if this were a multi-storied building. What you are looking at is a single story building with two mezzanines. That is how we got away with some of the construction items that were a little simpler to accomplish.

We have been in the building a year. Our latest checks with the survey gang indicates that we have experienced no settlement in that main building. There are nine settlement plates located in that building, so we can keep tabs on the thing. We really don't expect any problems. We don't foresee any unusual settlement conditions. If it should happen, we figure it will be fairly uniform across the building. But at this point, the building is good and stable. We have been operating in the main part of the building for a year. We just got the pre-inspection building into operation within the last 30 days. But, by and large, the site is not totally used. We saved ourselves a bunch of money building it the way we did. It was quite an interesting thing to see that much excavation and re-manicuring and re-configuring of the substructure, so that we could take advantage of conventional spread footings rather than having to put the whole site on piles. (Applause)

President Lewis: Are there any questions?

Member: How much of the taxpayer's money did this cost?

Mr. Weber: The total job cost the taxpayers about $127 million.

President Lewis: Any other questions? Thank you, Mr. Weber.

Before we go to the next feature, I would like to give you the final registration figures for today. We have 128 B&B; 167 Roadmasters; 183 Associates; 97 Guests; 64 Ladies, for a total of 639.

I would now like to turn the program over to Director Randy Karsten, who is the sponsor of the next special subject. Randy.

Mr. Karsten: Thank you, Don. Our next report is that of Special Subject No. 2, which is entitled ''Concrete Backwall and Seat Repairs. The chairman of this committee report is Mr. Mike Bradley. Mike is presently a project engineer for Conrail headquartered at Columbus, Ohio. Mike began his railroading career as a B&B carpenter and was then promoted through the ranks of foreman, inspector, and in 1982, was promoted to assistant supervisor of structures. In 1985 Mike was advanced to the position of supervisor of structures and then to his present assignment of project engineer. He received his Associate Degree in civil engineering technology just last June. Mike.

SPECIAL SUBJECT NO. 2

Concrete Backwall and Seat Repairs

Chairman: M. L. Bradley, Proj.Engr., Conrail, Columbus OH

Committee: D. G. DeBerg, Engr.Rail-Fld., AT&SF, Topeka KS
R. C. McMaster, Mgr.Fac.& Str.(Ret.), B&LE, Greenville PA
S. Lipkus, Br.& Str.Engr., CN, Edmonton ALB
J. A. Goforth, Chf.Engr., (Ret.), Clinchfield RR, Erwin TN
A. S. Uppal, Reg.Engr.Br.& Str., CN, Winnipeg MAN
R. E. Early, Fld.Supt.& Epoxy Tech., Crete/Tech, Fullerton CA
R. C. White, Jr., Pres., Coastal Gunite Construction, Easton MD
C. R. Covill, Asst.Supv.Str., Conrail, Northwood OH
J. R. Morbitzer, Supv.Str., Conrail, Columbus OH
R. Stucky, Pres., Marbri Engr.& Supply, Parma OH
R. E. Emmerich, Mgr.Engrg., Osmose, Madison WI
D. B. Cullum, Dist.Mgr., Prepakt Concrete, Batavia IL
P. Ackery, Tech.Rep., Rescon Technology, Casper WY
M. D. Anderson, VP, Rescon Technology, Casper WY
J. Bartholomew, Chemist, Rescon Technology, Casper WY
J. A. Lileikis, Mgr.Br.Mtce., UP, Omaha NE

Introduction

Although concrete bridge members are generally durable and provide good service, deterioration eventually occurs. At this time we are faced with decisions; what caused the deterioration; can it be repaired; and what technique will be most suited?

This report has been designed to review repair methods commonly associated with techniques used within our industry today. However, first portland concrete will be reviewed to provide a brief history of the radical changes that have occurred since its introduction and use in the United States. Then some typical deterioration causes affecting railroad structures today will be pointed out. Therefore, our outline for this report is:

I. Portland Cement Concrete
II. Deterioration Causes
  A. Freeze/thaw cycle
  B. Impact
  C. Low strength concrete
  D. Overloading
  E. Corrosion
III. Repair Methods
  A. Cast-in-place
  B. Grillage installation
  C. Shotcrete
  D. Preplaced aggregate
  E. Polymer use
  F. Precasting
IV. Conclusion

Portland Concrete

It was in 1824 that an Englishman from Leeds, J. Aspdin, invented the preparation process currently described as Portland cement. This very high roasting temperature produced a cement whose hardness was clearly superior to those used up until that time. It was named Portland because the mortar prepared from this new cement was like the rock from the Isle of Portland.

The high cost of importing Portland cement and the well-established use of natural cement retarded familiarity with, and demand for, portland cement in the United States, and it was not until 1871 that the first mill of importance was put in operation at Coplay, Pennsylvania.

Since Aspdin's development, portland cement has been mixed with fine aggregate, coarse aggregate, and water in producing Portland concrete ranging in compressive strengths from 1,000 to 3,000 psi during the late eighteen hundreds, to current day strengths ranging from 3,000 to 10,000 psi and higher depending on the leanest of the mix. However, it was not until 1918 that Abrams discovered that the water-cement ratio required proportioning to develop concrete of consistent strength. Until this time very little knowledge existed on concrete mixes, and in fact, experienced engineers of that time claim that Abrams' discovery was not taken seriously until around the 1950s, explaining one

Low strength concrete.

reason for poor concrete of that era.

With the development of high early strength concrete in 1930 along with other admixtures such as air entrainment in 1940, retarders and superplasticizers, concrete strengths have increased dramatically to where they are today.

Deterioration Causes

Freeze/thaw cycle — water infiltrating through the porous concrete, freezing and thawing numerous times resulting in a scaling and spalling concrete.

Impact — the traversing of moving loads, normally from a forgiving track structure to a rigid structure, over-stressing the bearing causing it to subside into or crack the concrete. The presence of a neopreme pad may assist in reducing impact and the lateral forces exerted by the bearing plate.

Low strength concrete—a direct result of improperly designed mixes, using contaminated or inadequate materials such as water or reactive aggregates from an adjacent stream or quarry, poorly placed and cured concrete.

Overloading—caused by undersized bearing plates; non-hinged bearings over-stressing the front portion underneath the bearing, both a result of low or pumping bearings and spalled concrete. Backwall tipping results from raised bridge spans and inadequate construction for today's loadings.

Corrosion — attacks anchor bolts, reinforcing and expansion bearings. This results in diagonal cracks protruding from the anchor bolts, concrete spalling exposing the reinforcing bearings and large sections divorcing completely from the abutment or pier due to thermal stresses produced at the anchor bolts from the superstructure.

Cast-in-Place

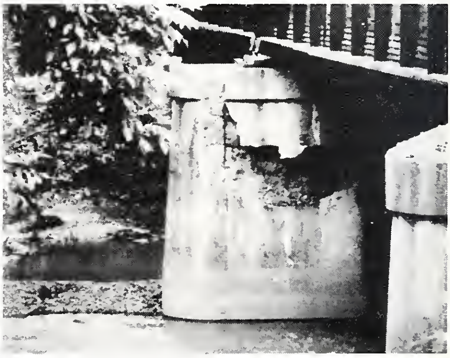
Since the cast-in-place method was employed during the original construction phases, it probably was also the first type of repair method utilized, simply because of the familiarity with the process.

Our first step would be to make an analysis of the problem area. This could be accomplished through the use of hammers for sounding loose concrete, air or electric drills noting depths of weak areas, or a core drilling machine extracting samples. Once the extent of deterioration is known, a repair plan is developed giving full consideration to minimizing the interruption of train traffic.

When the cast-in-place method is employed, deterioration is often severe enough that before the repairs can begin, shoring of some type must be installed to support either the track, in the base of a backwall, or a main girder for a bridge seat.

For backwalls, rail supports having a different section modulus are available providing sufficient support for openings parallel to the track ranging from six to ten feet in length. However, in the case where a deep backwall is to be reconstructed, wide flange beams spanning greater distances may be used. Although in the latter case, a timber mat or another suitable bearing area must be constructed on one end, while a design for supporting the other end is completed at the end bearing stiffener.

In bridge seat repairs, shoring will probably be provided through the use of either a steel or timber bent. Here, we are dealing with considerable large end reactions imposed from one or more main bridge members. Under these circumstances, the bent should be sized to support the vertical loads applied, along with providing a sufficient mat in which to transmit the load from the bent to whatever soil condition that may exist.



Thermal stresses caused by frozen bearings.

Once the supports are in place, removal of the unsound concrete is completed through the use of heavy equipment, pneumatic guns, and hand tools. If removal of the concrete has exposed more than half the perimeter of the reinforcing bar, it is recommended that the bar be completely exposed providing sufficient clearance under the bar to assure encasement and bond.

Sandblasting is often required to remove any laitance remaining on the concrete or corrosion on the reinforcing steel. It is important that during this process the air compressor be equipped with a functioning oil trap to prevent contamination to the surface.

Forms of lumber, steel, aluminum, fiberglass, or plastic are placed to the desired size, shape, and alignment of the body to be constructed. Form ties are often used to resist the lateral forces subjected to the formwork by the fresh concrete, vibrators, scaffold, manpower, etc. Several kinds of form ties are available, and the choice is most often due to the erector's preference.

Cast-in placing backwall.

No placement of the fresh concrete will be permitted until the area that the surface to be in contact with the fresh concrete has been soaked for a period of at least one hour or a bonding agent applied. This eliminates the water in the fresh concrete from being absorbed by the existing structure.

AREA recommends a minimum compressive strength of 4,000 psi for structural concrete with air entrainment of three to six percent usually being incorporated to resist the freeze/thaw cycle. Yet, five different types are made available for particular advantages:

I — General construction
II — General construction exposed to moderate sulfate action when lower heat hydration is required
III — When high early strength is required
IV — When low heat hydration is required
V — Used when high sulfate resistance is required

In placing concrete, it should not be allowed to drop freely through more than three or four feet or drop chutes should be used. Placement should also continue at a uniform rate as to avoid cold joints caused by long intermittent time frames. Internal vibrators are usually preferred to consolidate the material and shall deliver not less than 3,000 impulses per minute.

Curing may be accomplished by seven days of continued watering or applying a curing agent capable of entrapping the moisture in the concrete. Special provisions will be required if curing is to be completed during times of adverse weather conditions. After the concrete has set to sufficient strength, the forms are removed carefully to avoid chipping and spalling the green concrete. Any form tie depressions should be clipped at least one inch inward from the surface and honeycombing patched with a non-shrink grout.

Before backfilling with clean material, in the case of a backwall, drainage is provided through a perforated pipe and a damp-proofing material is applied to the concrete to resist the passage of water.

Full or partial replacement of the backwall or bridge seat depends on the extent and cause of the deterioration. For example, a backwall with minimal tipping may be supported by casting buttresses atop the bridge seat for additional support or holes drilled through the backwall into the abutment and reinforcing bar grouted with a non-shrink material to resist any further tipping, provided enough clearance is available for the superstructure to expand.

Steel Grillages

Steel grillage beams are used to transmit the vertical loads applied from the masonry or bearing plate to some proposed or established elevation after the unsound concrete has been removed. This method is much quicker than conventional concrete placement because of the curing period required for concrete to develop sufficient strength before the load can be applied.

It wasn't until the mid 1900s that design standards were set for grillage construction. Prior to this time, grillages had been constructed from

Grillage constructed from H-piles.

fit rail and small I-beams. Although no specific criteria existed during this period, railroad personnel felt this to be a satisfactory repair, and, it was in most cases.

Grillage dimensions are determined by the allowable bearing value of the concrete. AREA establishes this value at 1050 psi, yet several railroads set their criteria somewhat below this limit. I-beams are often used rather than wide flange beams because of the narrower flanges and thicker webs; however, the material available may govern grillage construction, and, at times, H-pilings have been known to be used.

Before the grillage is designed, a good analysis is required to determine the degree of deterioration. Once this has been completed by methods previously mentioned, the designer has parameters with which to design.

Again, temporary shoring will be required at the time the unsound concrete is removed and installation of the grillage completed. After all the deteriorated concrete has been removed to the desired elevation (providing the concrete is sound) a polymer grout is placed leveling the area, and the grillage installed.

It is important to know at this time whether or not the web was designed to resist buckling before or after the concrete surrounding the grillage is placed. If the concrete was designed to resist buckling at the web, the temporary shoring must be left in place until the concrete has hardened sufficiently. Only at this time will the bridge be lowered atop the repair.

Shotcrete

Shotcrete is mortar or concrete conveyed through a hose and peneumatically projected at high velocity onto a surface. The force of the jet impacting on the surface compacts the material. Properly applied shotcrete is a structurally adequate and durable material. However, these favorable properties are contingent on proper planning, supervision, and on the skill of the application crew, particularly the nozzleman.

In general, the physical properties of sound shotcrete in place are comparable to those of conventional mortar or concrete having the same composition. Most reported values for 28-day strengths are in the range of 3,000 to 7,000 psi, although some test panels have developed strengths up to 10,000 psi.

There are two basic types of shotcrete: the dry mix and the wet mix. In the dry mix process the mixing water is added at the nozzle, while in the wet mix process all of the materials are pre-mixed before the material enters the delivery hose on the way to the nozzle. Either process is suitable for repairing unsound concrete. Yet, differences in the cost of equipment, maintenance, and operational features may make one or the other more attractive for a particular application.

Where shotcrete is to be used for repairing deteriorated concrete, it is essential that all unsound material first be removed. Chipping should continue until there are no offsets in the cavity which would cause an abrupt change in the thickness of the repair. No square shoulders should be left at the perimeter of the cavity; all edges should be tapered. Improper preparatory work is responsible for more shotcrete failures in repair work than any other single factor.

Reinforcement should be rigidly secured in its desired position; clean and free from loose mill scale, loose rust, oil, or other coatings that may interfere with bonding. The minimum clearance between the reinforcement and the form or other backup material may vary between one-half inch for a mortar mix and wire reinforcement to two inches in the case of a concrete mix and number five reinforcing bars. If necessary form work constructed of plywood

Shooting shotcrete.

or other suitable material should be placed to permit the escape of air and rebound during the gunning operation.

Just prior to receiving shotcrete, all of the surface should be thoroughly cleaned by sandblasting. This should be followed by wetting and damp drying. In actual practice, the nozzleman usually scours clean the area ahead of the application with an air-water jet, then the water is shut off and all free water is blown away by compressed air.

In the gunning operation, each layer of shotcrete is built up by making several passes of the nozzle over the working area. The shotcrete should emerge from the nozzle steadily, without interrupted flow. Should the flow become intermittent for any cause, the nozzleman should direct it away from the work until it again becomes constant. The distance of the nozzle from the work is usually between two and five feet for the best results.

Where a layer of shotcrete is to be covered by a succeeding layer, it should be allowed to take its initial set. Then all laitance, lose material, and rebound should be removed by brooming. Any laitance which has been allowed to take final set should be removed by sandblasting and the surface cleaned with air-water jet. Again surfaces to be shot should be damp.

The natural gun finish is preferred from both the structural and durability standpoints. There is danger that further finishing may disturb the section, harming the bond between shotcrete and reinforcement, creating cracks in the shotcrete.

Good curing is particularly important; it is generally recommended that surfaces be kept continuously wet for at least seven days. Membrane curing may also be permitted where no additional shotcrete or paint is to be applied.

Preplaced Aggregate

In this procedure clean coarse aggregate is preplaced in the form, and a grout of sand, cement, water, and admixtures is injected into the voids of coarse aggregate where it hardens to form concrete. This method was first described in an application for a U. S. patent by L. S. Wertz in 1940, known by its registered trade name ''Prepakt''.

Similar to the cast-in-place method, first the disintegrated area is removed to sound concrete, the damage or deteriorated reinforcing bars replaced while providing at least one-half inch clearance to assure bonding, and the form work set. However, in this method it is recommended that the upper edge of vertical repairs be sloped at a 45 degree angle to avoid entrapping air and water during the grouting operation.

The coarse aggregate is usually placed as the forms are erected. The fall distance is limited to ten feet unless aggregates are dropped directly into water. Care is taken to avoid large unrocked areas to reduce shrinkage within the repair. If the grout is to be pumped from vertical pipes, the pipe is placed before the aggregate.

Grout is normally injected through three-quarter to one inch inner diameter high pressure injection hoses, either vertically or horizontally. Vent pipes may be required to permit escape of air and water from enclosed spaces.

If the grout is injected vertically, the injection pipes are spaced four to ten feet on centers. It is usually necessary to provide sounding wells (slotted two inch vertical pipes) which are used to monitor the location of the grout surface with the aid of lines and floats. The lower end of the vertical pipe should remain a foot or so below the grout surface at all times.

For horizontal injection, grout is injected on about three-foot horizontal centers and two-foot vertical centers. Grout is injected until observed in the next highest vertical port and usually the second or third horizontal port.

During the injection process the forms are tapped or lightly vibrated on the outside face to bury the points of aggregate in contact with the forms, providing an unblemished surface.

Once the form is filled the top layer of grout should be screeded off slightly below the finished grade, aggregate chips placed into the surface, the upper layer vibrated with internal vibrators, and the concrete finished in the normal manner.

At least a few hours, but preferably a day or two before grouting, the forms should be filled with water. This saturates the aggregate and old concrete, so they do not absorb water from the grout. Water is always pumped in from the bottom of the formed area. Never flood the forms with water from the top. Water cascading through the aggregate will pick up dispersed fines and concentrate them at the bottom.

When the grout is pumped it will displace the water in the forms without being diluted. Nevertheless, if desired, the water can be drained or allowed to leak off slowly.

Most grout for preplaced aggregate concrete repair work is job mixed, usually in double-tub, vertical-shaft mixers holding from one-fourth to one-half cubic yards per tub. For large jobs, horizontal shaft mixers holding up to five cubic yards may be used.

The grout most often consists of two bags of Type I or Type II cement, one 70-pound bag of fly ash, and three cubic feet of sand. A 3:1:4 mix normally produces 4,000 psi concrete within 28 days and about 5,000 psi in 90 days.

Some advantages of the preplaced aggregate method are:

a. It has wide use where ready-made concrete is unavailable.
b. Equipment and materials can be transported easily.
c. It has more aggregate than conventional concrete, therefore less shrinkage for repairs eliminating some of the strain at the bond surface.

Polymer Use

Polymer Concrete (PC) is a composite material formed by polymerizing a resin or monomer binder and a graded aggregate mixture, without portland cement. (Examples would be epoxy materials, metamethacrylate (MMA), and polyester resins.) It is used primarily as a patching material.

Minimum concrete repair with a polymer grout.

Often polymer concrete is considered a separate material from epoxies. This is not true, however, as the difference lies only within how the polymerization process is completed. Polymer concrete, as it is commonly referred to, is fully polymerized through a monomer system catalized with an initiator such as metamethacrylate (MMA), while epoxies containing a resin or organic polymeric liquid are semipolymerized, and are converted to a solid through the use of a curing agent. PC materials are being widely used in the areas of the bridge seat, where the time window for repair is limited, and deterioration is not severed. MMA mixtures offer higher strengths, faster setting times, easier mixing, and can be placed in one lift. Yet epoxy mixtures offer less shrinkage, are easier to use, and can be acquired in prepackaged form from the supplier. Therefore, not any one particular PC material is compatible for all applications.

The material selected is most often chosen from a supplier's list made available through a manufacturer. Yet special formulations are not uncommon, as they can be mixed and tested for placement in freezing weather or within curing times of less than one hour for desired strengths. Considerations for selecting a material are:

- Strength desired
- Pot life
- Bonding characteristics
- Temperature during placement
- Cure time
- Thermal properties
- Viscosity

First all loose, deteriorated, and unsound material is removed. Any moisture on the concrete surface should be removed unless it is known that the adhesion of the PC material to be used is not affected by moisture. Any exposed reinforcing steel in the repair area should be cleaned by a mechanical abrasion method. Forms may be placed if required and the PC placed to the desired elevation.

For patches of three-fourths inch or greater, the sand should be combined with a coarse aggregate whose maximum size is one-third the thickness of the patch or less. The addition of coarse aggregate, along with the fine aggregate, reduces both curing shrinkage and coefficient of thermal expansion. This is an important factor, because one of the major differences between polymers and concrete lies in their coefficients of thermal expansion and, if improperly designed or mixed, delaminations can occur.

Epoxies are often associated with crack injection, through drilling holes at close intervals along the cracks, installing entry ports, and injecting the epoxy under pressure. Cracks as narrow as 0.002 inch to one-fourth inch can be bonded by an epoxy compound, whereas an epoxy resin mortar should be used for wider cracks. The use of sand or powder as an aggregate for cracks one-fourth inch and greater reduces the thermal properties during injection and curing processes.

TABLE 3.1—COMPARATIVE MECHANICAL PROPERTIES OF EPOXY SYSTEMS AND CONCRETE

	Flexural strength psi (MPa)	Tensile strength psi (MPa)	Compressive strength psi (MPa)	Elongation percent
Structural concrete (typical)	500-1000 (3.45-8.90)	300-700 (2.07-4.83)	3000-10 000 (20.68-68.94)	0.01
Epoxy compounds (typical)	1500-5000 (10.34-34.47)	500-5000 (3.45-34.47)	500-12 000 (3.45-82.73)	0.2 to 50

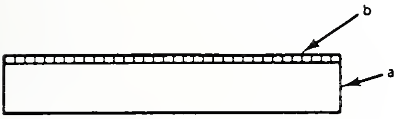


Fig. 3.3—A layer of epoxy (b) adhered to a thickness of concrete (a)

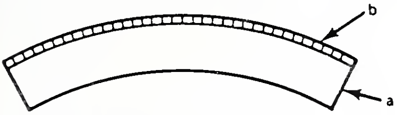


Fig. 3.4—The effect of temperature increase in an epoxy-concrete system

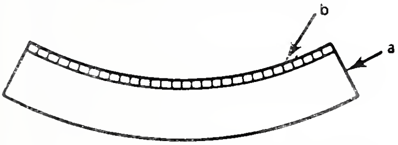


Fig. 3.5—Effect of temperature decrease in an epoxy-concrete system

Strength-temperature chart comparison.

An analysis of the structure is usually performed to identify the cause of the cracking and to estimate the extent of deterioration. Core drilling is often utilized for this purpose although other scientific methods are available. If cracking is extensive a repair plan is usually developed.

The first step is to clean the cracks that have been contaminated. Oil, grease, dirt, or fine particles of concrete prevent epoxy penetration and bonding. Preferably, contamination should be removed by flushing with water or other specially effective solvent. The solvent is then blown out using compressed air, or adequate time is provided for air drying.

Surface cracks should be sealed to keep the epoxy from leaking out before it has jelled. Where the crack face cannot be reached such as in backfill material, this often is an adequate seal.

The two most common methods of installing entry ports are drilling holes into the crack approximately three-fourths inch in diameter and bonding the nipple or tire valve stem with epoxy adhesive or to provide an entry port by bonding a fitting flush with the concrete face over the crack.

Mixing the epoxy is done either by batch or continuous methods. In batch mixing, the adhesive components are pre-mixed according to the manufacturer's instructions by mechanical stirring or mixing paddle. Care must be taken to mix only the amount of adhesive that can be used prior to commencement of jelling of the material. When the adhesive material begins to jell, its flow characteristics begin to change, and pressure injection becomes more and more difficult.

In the continuous mixing system, the two liquid adhesive components pass through metering and driving pumps prior to passing through an automatic mixing head. The continuous mixing system allows the use of fast setting adhesives that have a short working life.

Injection of epoxies is generally performed under pressure. The pressure of the injection port of the epoxy adhesive can vary from near zero psi to over 2,000 psi. The pressure used for injection must be carefully selected. Increased pressure often does little to accelerate the rate of injection. In fact, the use of excessive pressure can propagate the existing cracks.

If the crack is vertical, the injection process should begin by pumping epoxy into the entry port at the lowest elevation until the epoxy level reaches the entry port above. The lower injection port is then capped and the process is repeated at successively higher ports.

For horizontal cracks, the injection should proceed from one end of the crack to the other in the same manner. The crack is full if the pressure can be maintained. If the pressure cannot be maintained, the epoxy is still flowing into unfilled portions or leaking out of the crack.

After the injected epoxy has cured, the surface seal should be removed by grinding or other means. Fittings and holes at the entry ports should be painted with an epoxy patching compound.

Cores may now be extracted to further evaluate the effectiveness of the repair. If any area is found unsuitable, the process is repeated in that area and tested again.

Various polymer formulas or mixes are available for use dependent on certain factors: curing time, crack size, viscosity, strength desired, and bonding characteristics.

Pre-casting

The field of pre-casting a bridge seat or backwall has been very limited in replacing existing concrete, mainly due to the time window required and the need for precision workmanship for installing. Yet, a few cases have been known to be successful under the right conditions.

First, an analysis is conducted to determine exactly how much concrete will be removed, and a plan is developed for setting the member. Then drawings are completed for the casting operation, and the beam is cast. Once the beam has arrived, heavy equipment is required to quickly excavate the material behind the backwall. Then pneumatical 90 and 30 pound air guns are used to remove the unsound concrete to the desired level.

Prior to setting the pre-cast section, the concrete is drilled to matching holes in the backside of the pre-cast wall, the concrete cleaned, and a polymer grout placed to level the area filling any voids that may exist. Now the section is set to proper alignment and elevation with a non-shrink grout being placed in the holes prior to installing the rebar for tensile and shear strength. The damp proofing is now applied, a drainage pipe installed, clean fill placed and compacted, and the track work completed.

Conclusion

Since portland concrete's use began in the United States its strength has increased dramatically with the developments of the water-cement ratio, admixtures, and the knowledge gained through a century of use. But, with the age of our structures and heavier loads traveling our lines today than what they were designed for, problems will continue to develop.

The decision for the bridge department would be what method of repair is most suited for each particular situation. This, no doubt, hinges on the engineer or supervisor's knowledge of methods made available to him, along with the manpower and equipment available. He should, however, recognize their advantages and disadvantages before selecting the method. Thank you. (Applause)

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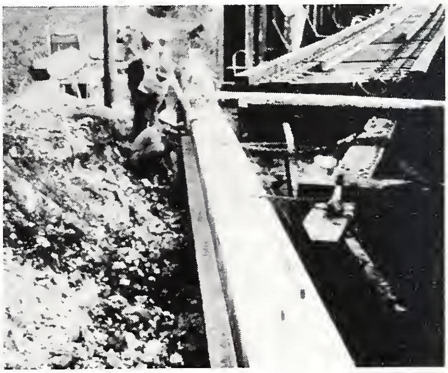
President Lewis: Are there any questions of Mike? That was very interesting, Mike, thank you.

We will meet tomorrow morning at 8:30 a.m. in the Red Lacquer Room for the second joint session. Today's session stands adjourned. Thank you.

Adjourn

Injecting epoxy in compound.



Pre-cast backwall in place.

TUESDAY MORNING JOINT SESSION

September 20, 1988

President Snyder: The second joint session of the Roadmasters and Maintenance of Way Association and the American Railway Bridge and Building Association will now come to order.

Ladies, gentlemen, members and guests, on behalf of the Roadmasters and Bridge and Building Associations, I welcome you to the second joint session of this conference here in Chicago.

The registration this morning is as follows: B&B 128; Roadmasters 167; Associates 183; Guests 97 and Ladies 64, for a total of 639. This is a pretty good turnout. By the way, pre-registration was 150, so you people can save yourselves a lot of trouble if you pre-register. I understand that those people who did were very satisfied with the way it worked out. So we are hoping that some time in the future, everyone will pre-register.

It is my pleasure at this time to introduce this morning's keynote speaker, Mr. James A. Zito, senior vice president operations of the Chicago and North Western Transportation Company. Mr. Zito has been ill and, in fact, he comes from his sick bed to address us this morning, and I am very thankful that he is able to be with us this morning.

Mr. Zito assumed his present position in 1976 and is responsible for the Chicago and North Western Transportation Company's transportation, engineering, mechanical, purchasing, and quality improvement functions, affecting freight operations in nine states and suburban passenger operations serving 80,000 daily riders in the Chicago area.

Mr. Zito began his career with the North Western in 1944. Since that time he has served in positions of increasing responsibility, including assistant trainmaster, trainmaster, assistant superintendent, division superintendent, division manager, assistant general manager, and assistant chief engineer-maintenance.

Mr. Zito attended Elmhurst College and completed the Senior Executive Program at Stanford University. He is a member of the American Association of Railroad Superintendents, the Chicago Railroad Superintendents' Association, the American Railway Engineering Association, and is a member and past chairman of the Operating-Transportation General Committee of the Association of American Railroads, chairman of the Energy Research Committee and member of the Research Executive Committee of the Association of American Railroads.

Jim, welcome to the Roadmasters and Bridge and Building Conference.

KEYNOTE ADDRESS

James A. Zito

Senior Vice President Operations
Chicago and North Western Transportation Company

James A. Zito

Thank you, Ray. Good morning ladies and gentlemen. I really am happy to be here. I was supposed to speak before a group yesterday at the Hilton and I didn't make it. I feel a lot better this morning. I had some kind of bug.

I am glad I am speaking before the maintenance-of-way people today and not the signal department because coming in on the train this morning, we had about a half hour delay. That's probably why some of the people were late getting in here. I hope they don't find that it was an insulated joint. Anyway, coming in on the train this morning, I was thinking about talking here and I was reminded that when my dad came to this country, he came with a cousin from Italy. My cousin went to work for the B&O Railroad in the maintenance of way department and, in fact, he retired from there some years ago as a section foreman.

That was my cousin Vito, and the story in our family is that when he went for his citizenship, a judge in the federal court was testing him. Vito was so proud of how he had prepared for his citizenship that he had invited all of his family and friends, and you can imagine how big an Italian family is with all the cousins and so on. So they were all in the court room while he was being questioned by the federal judge. The federal judge said, ''Vito, I'm going to ask you a few questions. Who was the first president of the United States?'' Vito said, ''It wasa Georgea Washington''. The judge said, ''That's right. That's very good. Now who was the sixteenth president of the United States?'' Vito said, ''Youra honor, the sixteentha president of the United States wasa Abraham Lincoln.'' The judge said, ''That's good.'' And Vito said, ''Anda Judge, Abrahama Lincoln, he was assassinated.'' The judge said, ''Vito that really is good. You are really up on your American history. Since you know that, I want you to tell me who it was that assassinated Abraham Lincoln.'' And a puzzled look came over Vito's face, and he stammered, paused, shook his head from side to side. And the judge said, ''Now, Vito, you understand the question? Who was it that assassinated Abraham Lincoln?'' Vito just hemmed and hawed and didn't say anything and finally the judge said, ''I'm only going to ask you one more time, Vito. Who killed Abraham Lincoln?'' And just then from the back of the court room, someone stood up and said, ''Atsa boy, Vito, don'cha you be a stool pigeon!'' (Laughter) Needless to say, he got his citizenship.

I once read that when someone has a chance to talk about an important subject they should make every effort to give their message clearly, correctly, and concisely. The theory goes that speakers should do this because an audience has rights—like a customer has rights—to a product that meets their needs. I subscribe to that idea.

The time allowed for this talk by your program committee insures reasonable conciseness. All that remains for me to do is be clear and correct in my information.

But since part of my obligation has been taken care of for this talk, I have decided to add a requirement. The requirement is that, by the time I am done, I will have obtained a degree of commitment from each of you to champion the cause of an employee-involvement-driven

Total Quality System in the rail industry. I will define a little later what we mean by those terms.

I will also explain why I firmly believe our industry must adopt this philosophy and why this concept of involving employees in Total Quality is fundamental to productivity.

First I want to talk about productivity, particularly a way of looking at productivity itself that I find useful and one that helped form the foundation for my commitment to Total Quality through employee involvement.

I know about a productivity model that is simple, yet I believe it is complete. The model states that all productivity improvements come from three distinct, yet related areas: the first Technology, the second is Organization and Systems and the third is People.

Most experts agree that Technology provides the big leaps in productivity. Technology can produce the "mega jumps". The diesel locomotive was a classic example. The use of copy machines and computers are even more dramatic. Some of the new track maintenance machines are further examples.

Within the second area, Organization and Systems, innovation can produce dramatic productivity improvements. New ways of collecting, analyzing, and distributing data, and more efficient organization of resources are broad examples of this area.

Finally, the third area of this productivity equation, People. This area is unique in that it is both a component of the equation and a catalyst for the other two components.

People are obviously a component to productivity in that they can, by themselves, create more productive ways of doing things. Just for a moment consider the implications of that. Sometimes, I think we tend to forget how good people can be. For example, people can, out of their own resources of creativity, intelligence, and energy, become more efficient and productive.

And, of course, people do this without any investment in new circuit boards, replacement parts, or mechanical overhaul. But, as I said, that is not all that is important about people. I mentioned that people are a catalyst to the other two factors in my equation.

When people are included in the proper measure and at the right times, they enhance the benefits of technology or system improvements. In fact, unless the affected people are properly included, it is rare that the full benefits of improvements in Technology, Organization, or Systems will be achieved.

But don't take my word for it. Think back to your own experiences. How many of you have been involved in introducing a new technology, or getting a new way of doing things started, where there was really nothing wrong with the technology, or the method—yet, all kinds of problems seemed to crop up?

Why do these problems occur? And what are the implications? Well, at the North Western, we have come to believe that most of these problems occur because the people affected by the technology, or that have to actually work with the new equipment or system, were not involved early enough and/or completely enough. Their input was rarely sought and almost never used.

Now, since we know we need all the productivity improvement we can get, we believe the implication is that we better start getting people more involved right now. We need all our peoples' ideas and enthusiastic involvement in improving productivity if we are to provide service for our customers, jobs for our employees, and returns to our investors.

But how do you get all the people involved? What will cause people to want to be involved? And, if you solve that problem, how do you encourage managers and supervisors to actually involve the people early and completely? How do you overcome the resistance in your organization?

Our answer was to recognize we had to commit to some fundamental changes. We had to commit to a concept of Total Quality. That means really working together to do things right the first time. We find that the idea of working together to do a quality job is a concept that all groups identify with. It is one which people at all levels see as benefiting them as well as the company. It is a concept that seems to resonate with something deep inside people. I had one carman tell me that "Knowing the right thing to do, and doing it, means that you know when you do your work it is useful and worthwhile. In short, you are doing a quality job."

That is the kind of attitude our system is designed to foster. So, I am going to take some time to explain the basics of this system and state how we believe this system works to improve quality and productivity and encourage the involvement of all the people.

First of all, this system operates on some fundamental beliefs about people. We believe that: (1) just about everyone is capable of coming up with good ideas, and (2) just about everyone wants to do a good job, and (3) it is almost impossible for people to resist the honest opportunity to influence how their job should be done.

You know, a lot of people, when they hear statements like that, say to themselves, "Yeah, yeah, I know about that stuff," then they shrug it off. But I am here to tell you that unless you keep those ideas in your mind and act on them on a daily basis, you will never use your people effectively and consequently you will not be a competent manager.

Because, given those beliefs, you cannot avoid reaching the conclusion that the people doing the work are outstanding sources for good ideas about how to do the work better, and that you had better figure out how to get those ideas. Let's face it, in many situations, the people on the job have better ideas about their job than a civil engineer or a mechanical engineer, or even a senior vice president.

Okay, let's assume you accept these beliefs. It sounds like all you have to do is let people give their ideas. Everything looks great and sounds easy. But, it is not so easy. Especially when your company style has often been "Do it; don't ask questions, and, most of all, don't bother me with dumb ideas."

Against that history, it may be risky to walk out to a work group and say, "Hi fellas, let's think up some great ideas about how to be more productive". In fact, it is likely to get you responses that range from cold silence to "Why don't you do it, you're the boss. You get paid to come up with the big ideas", to responses not suited to be repeated in polite society. But I will bet most of you can fill in the blanks.

The fact is, that in order to tap into the wellspring of creativity and common sense that exists out in your work force, you must make some major changes. You must examine and improve all aspects of how you deal with your people. You must examine and improve the systems that create the attitudes present in your company. In short, you must examine how you operate your company and make needed changes.

The means to do this must be an overall system well thought out and planned. It must be one that impacts at all levels and in all areas. Thus the statement of "Total Quality Improvement System." This is a big undertaking, one that requires considerable investment of time and money.

Based on the recognition of the investment needed, I guess at this point it is only right for me to say a few things candidly, particularly to bottom line thinking. For example, if you were to ask me what single item could bring about the biggest improvement in productivity in our company, I would immediately answer "work rule changes". Asked further if our Total Quality Improvement System is designed to address this specific area, I would say, "no — not directly anyway", and then only to the extent that by developing better rapport and trust between all people in our company, and by soliciting ideas, we might reach better agreements.

But does this lack of direct impact on work rules create an excuse for those who consider themselves "hard nosed" railroad people, to shrug this system off as not addressing the "big dollars"? Well, first of all, let's look at "big dollars".

How big is 20 to 30 percent of your gross revenues? That percentage figure is significant because that is how much money experts in this field say is misspent in most companies because of poor quality outputs. You know, things like cars getting on the wrong train, repairs done poorly, instructions misunderstood—I could go on, but I think we are all familiar with what bad quality is.

Let me take a minute to say something about those "expert statements". I asked one of our people involved in our Quality System how these "experts" came up with these figures. He said he had never actually seen the detail of any studies, only reports, but he believed the figures because of an exercise he did. He asked me to do it and it's one that I am asking you to do when you get back to your desk.

When you get back, take your company phone directory and look at each department and section, and, if you have time, look at each job. Estimate what percentage of each department, section, or individual's time or budget is spent on correcting things that were done wrong the first time. Think about the time **you** spend.

By doing this, I became convinced that the figures were right. In fact, they may have been conservative. Go back to the dollar amount that is 20 to 30 percent of your company's gross revenue. Isn't that a figure that should get the attention of even the hardest "hard nosed" railroader? Well, it should, because that is the potential return for producing poor quality.

Anyway, at this point, hopefully you are willing to consider these points:

1. That it is likely a great potential exists for productivity improvement through a system focused on a quality attitude that has, as its goal, doing things right the first time.
2. That people are the key to productivity improvement because of their impact on the components of productivity.
3. That people will feel more motivated to participate in productivity improvement and to contribute ideas and effort when they believe they are actively participating in producing a quality output.

But, once you do become convinced of those points, what can be done with that information? How can a company actually get this system to happen? As I mentioned, our company decided that, to make the kind of changes we believed were needed, we had to develop a total system, not just a short-range problem.

Well, we have done a lot of work to develop a system that would be appropriate for a railroad. We continue to do a lot of work within our system. And, briefly, here are the elements:

1. Top management commitment and direction
2. Organization for management of the system
3. Education for skills and understanding
4. Implementation
5. Recognition
6. Evaluation and modification

Top management commitment is listed first, because any Total Quality System is eventually going to fail if it doesn't get top management support. But I do not think any manager has the right to hold off working to install employee involved Total Quality simply because your president has not become a Total Quality convert.

Sometimes it is like the riddle about which comes first, the chicken or the egg. Sometimes the people in a company get involved because the president becomes a believer in the benefits. Sometimes the president gets involved because he sees the benefits from people in the company who have become believers. So if your president is not convinced yet, maybe you should take some initiative and show what power lies in a cooperative work group dedicated to serving the customer.

In our company, I am proud to say that our former chief executive, Jim Wolfe, who, as many of you know, died recently, was the one who led our company into the Total Quality System. Jim Wolfe had many accomplishments and left many legacies to our industry.

But one accomplishment that could have the greatest lasting impact was his vision in being the first railroad chief executive to commit the considerable resources needed to start his company on the path toward an employee involvement driven Total Quality System.

I guess I would have to say that our company is doubly fortunate. Bob Schmiege, our new chief executive, has reaffirmed the dedication of our company to the system of Total Quality. Some of his first acts were to have our Quality Improvement Department report to him and he promoted the head of that department. He has also reaffirmed the Quality Policy as the guide for all people.

That policy, which was written at a meeting of all our top managers, including Jim Wolfe and Bob Schmiege, states how we intend to deal with our customers and our people. In reality, it describes how we will run our company. I want to mention a few points of the policy.

Essentially our policy says our goal must be to supply our customers with quality outputs. At the beginning of this talk I mentioned that I would explain how we define quality. Well, in our company, quality is defined as an output that meets the customer's requirements. This means our company must be driven by what our customers need. It means we must seek to change our way to match their way.

Let's face it, in some respects this is a major shift in thinking for many railroaders. I know we had, maybe still have, people who regarded the customers as difficulties to be endured. The customer was a noisy voice at the other end of the phone, always complaining. Unfortunately, some of our people seemed to think that any connection between that customer and their job was virtually non-existent, if they thought about it at all.

You know, I am not talking about people who didn't work hard, just people who confused their mission. They often got hung up on running the trains and lost sight of the fact that our reason for existence was to serve our external customers — our shippers.

Under a quality system, the focus is on the customer. And within our quality system, we have expanded the customer concept to include another type of customer, our internal customers. Everyone that works in a company has them. You have them. I have them. They are the people in the company who are receiving your output. One could be a person in the yard office, one certainly is your boss, and others are the people who work for you.

In fact, if you think about it, all the people in a company are linked, either directly or indirectly, in an internal supplier-internal customer network. What links us are the valid needs, the requirements of timeliness and quality we have of each other as we all work to meet the needs of our external customers.

One clear message I want to give you at this point is that you must understand and believe another concept. That concept is that in the supplier/customer relationship that exists between the boss and subordinate, the burden of change rests with the boss. The reason for that responsibility comes out of those beliefs about people that I talked about earlier. If most people want to get involved, and are not involved, we have to look to those who control the process that teaches and allows involvement. Like it or not, that's us.

You see, the overall goal of a quality policy has to be, to meet all customer needs, both internal and external. When we are meeting the needs of all our customers we are, without a doubt, producing quality.

In addition to our commitment to customers in our policy, we also make statements which contain specific guidelines for all managers and employees. Statements like, "Promote a climate of open communications which demands attentive listening and candid discussion in an atmosphere of mutual respect", and "Give every employee the right to know the requirements of his or her position, and the right to inquire as to their validity". We believe these guidelines must be followed if we are to tap into the creativity and involvement of our people. But we also state our expectations that "Every person will continually strive to know the right thing to do and to do it right the first time".

This policy formed the foundation for developing our system. It was used as a reference as we set up our organization, developed our training, and planned to implement our system.

The next phase, organization, meant total organization of our company for quality. All major management levels were given specific responsibilities to meet regularly to develop and implement the strategies needed to promote the quality system in their area.

Education came next. Education about the system and specific training in how to develop open communication, how to analyze your own quality performance, how to assist employee groups in solving problems, and how to encourage people to come up with better ways of doing the work. Our educational goal is to have all our employees trained in quality principles and problem-solving skills.

To start implementation we developed a formal system of soliciting employee ideas. When suggestions are received they are reviewed and decisions are made whether to implement immediately, form a (typically) multi-level employee project team to resolve the issue, or to return the idea with a carefully considered answer. All ideas get responses and most get action.

By the way, we have expanded this concept to the point to where we now have permanent quality teams with external customers. Teams composed of train crews and dock workers as well as managers from both companies. These teams meet, and, using our team processes, solve problems at the local level where people know exactly what is happening.

We know when people get positive recognition for their actions, they are encouraged to continue their efforts. In our Quality System we work hard to make sure the efforts of everyone who gets actively involved receives the right kind of recognition. Our recognition system is based primarily on honest, direct, person-to-person appreciation for effort and accomplishment. We do have some tangible items like pins, key chains, desk portfolios, and dinners, but these are simply symbolic items or appropriate ceremony. The heart of our system is the pride a person feels by doing a job well, having the opportunity to use their brains and experience, and having their efforts appreciated by the right people.

Our final step of the system is evaluation and modification. This step is, of course, never ending. Entering the Quality System has been like going on an endless trip. It is, as they say, a journey, not a destination. I will be frank, sometimes the road has been rough and rocky, but more and more, there are exciting accomplishments. We continue to evaluate our progress and make modifications as we see the need.

So there you have it. Simply stated, our Total Quality Improvement System is a total organizational commitment designed to involve all of our people in a united effort to meet our customers' requirements for service.

I have indicated it involves a lot of work and money, and it is not easy. I have also said that we are starting to get a considerable return from this effort.

Now you might be wondering something. If we have done all of this work and made all kinds of up-front investment, you might be wondering why we would be encouraging all of you to champion this concept of quality back at your companies? I mean, if it is so good, why share it?

You might come to the conclusion that perhaps this is some kind of subtle plot I am trying to put over on all of you! You know, kind of like the false plans that the Russians try to get their enemies to believe.

Well, if you were truly an enemy, I guess I might be tempted to try something like that; but you are not the enemy. Some of you are competitors; but more significant is the fact that almost all of you are cooperative partners in some aspect of our business. And, virtually all railroads represented here could say the same about the others.

So I am not being subtle, I am being plain and straight. I am encouraging you to champion the cause of Total Quality, because it is my belief that our entire industry must develop an attitude of continual Total Quality Improvement in serving our customers if we, as an industry, are going to survive and prosper.

I know that sounds like one of the platitudes typically stated in speeches, but let me explore a rationale that I think raises that statement from pure rhetoric to a pragmatic, accomplishable, and success-oriented strategy.

But let me put my argument in perspective. First, as railroads, we are active players in the new global economy. This is true no matter where you are located because our customers, shippers, and receivers, are dependent on how well our nation's products are doing on the world market. Steel and autos are easy examples to see what can happen.

Just think of the shock waves that have moved through our national economy, and through the rail economy, because of the problems in these industries. As significant partners with these industries, we played a role in their difficulties. When we damaged autos or failed to meet a schedule, we contributed to their customer loss. We, as an industry, often ignored quality—said it was too expensive—and often did not see that whenever we produced poor quality, it was the most cost inefficient product we could have produced. It is one that has come back to haunt us time and time again.

Through company management and union leadership attitudes, we taught our people not to care. We managed to develop agreements for running our business that prompted inefficiency, encouraged poor quality, and almost extinguished the natural inclination of our people to do a quality job. Couple this history with another fact about the railroad industry.

There are few industries where interdependence is so significant. I believe the implication of this interdependence means that if our industry is to gain market share, our industry, not just one or two railroads, must have the reputation of moving traffic the way our customers need it to be moved in terms of service and cost. This has to be true whether the move is local, transcontinental, or from border to border.

I talked earlier about the internal supplier-internal customer network that exists in every company. I illustrated how each person must adopt a commitment to quality if the output to the external customers is one which will meet valid requirements for quality. Further, I pointed out that people in a company can be both a supplier and a customer to each other—like you and your boss or you and those who report to you. When you think about it, it is easy to carry that logic of supplier/customer interaction to our industry. Perhaps it is even more apparent to the North Western because of our traffic patterns. But all railroads interact in this, now I am your supplier, now I am your customer interaction. And, of course, the focus of this interactive relationship is our ultimate relationship with our shippers.

Given our industry's reputation for quality, it is clear, we must change. We are interlocked, so to meet our customers' needs, we all must change.

Now I know we are not the only railroad that recognizes this. I know the North Western isn't the only railroad taking action. I know I am not the only one in this room who believes we must become more customer oriented. But I may be the only individual within this room who is actually passionate about this issue—I hope I am not. I hope all of you are passionate about this concept.

Because, to meet our customers' needs as they battle in the global economy, we need the commitment and dedication of every one of our railroad employees to quality service. And that commitment will not occur unless the leaders in the railroads become committed to the concept of Total Quality.

People joined together in an atmosphere of mutual respect, working toward a quality output for their customers, is an unbeatable combination. With this concept we can look to a new great era for the rail industry. Without it we continue the cycle of shrinkage that has affected our industry.

If you are not committed already, I urge you to investigate and evaluate this concept of Total Quality through people involvement. If you do, I honestly think you will join a growing number of business leaders in all industries who are convinced of the following concept—that a people-oriented, quality system must be the foundation of American business if our nation is to retain its place in the forefront of the global economy.

The railroads moved this nation through the industrial revolution. Let us be leaders in the quality revolution. Thank you very much for giving me the opportunity to address you this morning.

President Snyder: Thank you very much, Mr. Zito. I know you have a busy schedule, but you are certainly welcome to stay and listen to the remainder of our presentations. Hugh Fuller, would you like to introduce our first panel this morning?

Mr. Fuller: I sure would. Thank you, Ray. Our next presentation is a panel discussion sponsored by the Railway Tie Association. The title is ''Spent Cross Tie Disposition'' or in other words, what do we do with all those scrap ties out there? Our moderator, John Mabry, has had 50 years experience working for the Kerr-McGee Corporation. He is now the executive secretary for the Railway Tie Association. John.

PANEL DISCUSSION

Spent Cross Ties Disposition

Moderator: D. B. Mabry, Exec.Secy., Railway Tie Association, St. Louis MO
Panelists: D. C. Kelly, Asst.Chf.Engr.Sys., CSX, Jacksonville FL
F. Brogdon, Cedrite Technologies, Kansas City KS
D. L. Smoot, Sr.Exec.VP.,Indiana Hi-Rail, Connersville IN
R. S. Ohlis, Jr., VP, Koppers Co., Pittsburgh PA

Mr. Mabry: Mr. Fuller, Presidents Snyder and Lewis, ladies and gentlemen of Roadmasters and Bridge and Building, good morning. I want to tell you how very appreciative we are that Hugh Fuller and the program committee saw fit to work us into your wonderful schedule here in Chicago. Railway Tie Association is the voice of the wood cross tie and we address, this morning, a subject which is perhaps as pressing as any that you folks out on the firing line are confronted with—what to do with spent cross ties.

We are going to start with Dave Smoot. When Dave talked to you two years ago, he impressed me to the point where I asked him to participate here today, he was vice president and general manager. I see by his business card he is now senior executive vice president. To his right, Dave Kelly of CSX. Dave is assistant chief engineer systems. Next to Dave is Frank Brogdon of Cedrite Corporation. Next to Frank is Ray Ohlis, vice president of Koppers Company. And with those introductions, Dave Smoot, please tell the people what a guy on a little railroad does to get rid of spent cross ties.

Mr. Smoot: Good morning ladies and gentlemen. It is a pleasure to speak before the Roadmasters and Bridge and Building associations. I was here two years ago. I was thrilled yesterday to hear that one of the objectives of the organizations today is to involve the short lines and regional railroads in your respective Associations, and I do applaud you for that. We on the short lines do learn from our peers, and we certainly consider you our peers.

If you envisioned the Class I railroads and regionals and the short lines as three men standing up here you would find that all three of those men put their pants on the same way. Yesterday, the Santa Fe presented the Roadmasters Association with a report on tie disposal that counted ten items. I noted that out of those ten items there was probably an eleventh item that the short lines do that I should mention. Not that it is the best choice but it is probably the most used one, especially when we consider "ma and pa" short lines. That is you leave the used cross tie along the right-of-way and it becomes a monument to railroading. The problem with that for most of us short lines that are not "ma and pa" is that the farmers and the water conservation people certainly know how to find us when there is a blocked culvert or a drainage ditch. Secondly, it is certainly a safety hazard for our employees. Juvenile delinquents, as we like to call them, or trespassers, like to pile those up and see if something spectacular is going to happen; and they are usually disappointed. And thirdly, short lines are not immune from FELA, and I certainly don't want to contribute any negligence that would result in injury to one of my employees.

But going on from there, what do most of the short lines do? Well, we don't do anything differently than the Class I's do. The challenge is the same. The problem is the resources are probably much more limited. Our first objective in getting rid of spent cross ties is to minimize the cost to the railroad or to at least return some money back to the general fund. That is a two-edged sword that is generally not easy to use, and I am sure that on the Class I railroads the same problems emerge. We have to pick the cross ties up to get them off the right-of-way and bring them in to some centralized point. I suspect, on the average, on my railroad that is a cost of about two dollars a tie. We bring those in and sort them out. I think it is important that I inject into the conversation here the difference between my spent cross ties and probably your spent cross ties. Remember that I am upgrading most of my tracks to minimum Class I-Class II.

Yesterday we learned that on the Illinois Central Railroad "deferred maintenance" is a nasty term, and I couldn't agree more. However, most of the railroad lines that I have purchased or inherited through the years have suffered immensely from deferred maintenance. So the average cross tie that I take out looks more like a toothpick than a cross tie. The tie, if it has any use at all, if it is squared up, has any body to it whatsoever, if it comes out of the track, it becomes a retaining wall someplace, or it becomes a block to hold up a fuel tank or it becomes a block to hold up stacks of rail or anything else that may be out there. From there, the used cross ties that we do bring in that we decide to get rid of first, we try to sell those off. We try to find one party who may want to buy all of them. We have found that farmers are a good source for that particular job or task. They will generally pay cents on the dollar for them, up to two or three dollars, depending on how many we have and how quickly we want them removed. We have even gone to the extra expense to attract them by banding those cross ties in groups of sixteen or twenty to make them easier to load. As a matter of fact, we have even helped them if that will get rid of the ties.

We will approach a nursey if cross ties come in that are decent, but maybe in smaller quantities. However, most of the time a nursery wants a tie that is really fit for rail use and so we are kind of out of that market.

We move on from there. If we are not able to sell them, certainly we try to find a landfill that we can haul them to. That is a tough task as it was pointed out yesterday. The EPA has not come down yet with any federal guidelines on spent cross ties treated with creosote. They are leaving it to the state agencies. We have been successful in the areas where we operate in finding some landfills that will take them, but they are not a desirable item. And that is one of the lesser desirable things that we like to do with them. That costs us additional money.

Another way to get rid of the cross tie, of course, is to donate them to the public, and you run the risk there of injuries on the property, or worse yet, their taking the wrong cross ties. People sometimes think that those scrap ties could not obviously be the ones we are wanting to give away; they are not worth picking up. Nevertheless, it does require a little office time and personnel, which is an aggravating thing. We make everyone sign a general liability release when they are picking these up at a manned station. We don't let the ties lie along the right-of-way. We have found from experience, that leaving them lie along the right-of-way results in more damage than good when the public is involved in picking up things. They tend to think that tracks are suitable to drive down and that tends to break down what few ties we have left behind that we thought were salvageable.

If we can't give them away, if we can't haul them economically to a dump, if we can't find someone to buy them, what do we do with them? Well, we have buried them along the right-of-way. That is another less desirable idea. And we have explored the possibilities of calling our Class I brothers asking if we can piggyback our spent ties onto theirs to get rid of them. Generally the answer is ''no'', they are not interested in any additional ties for shipping out. So we are left with a dilemma and we have built monuments to ourselves. I have some stacked up right now waiting to find homes. One of the things that we really don't have the resources to do right now is to use a new technological burning and shredding plant, but they are really not open to the short lines for marketing purposes because the cost is prohibitive to ship to them. If those plants were on my own railroad, that would be one thing, but I don't have enough resources right now to attract them.

So what's in line for the future for the short lines and spent cross ties? Well, we are looking to see what is coming out of these conferences. We are looking to the tie manufacturers who we do business with to see what they are developing. We look to our Class I peers to find out what is going on. We certainly want to be involved. We don't want to be left out in the cold. We want to be involved to the extent that it is economical for us to get rid of these spent cross ties and, therefore, I can only say to you that it is in our best interest to work together. We are an emerging group, we have had our setbacks here recently with the courts, but we will rebound and all those branch lines that you still have out there and some of your secondary main lines will fall into the hands of the regionals and short lines. And together, collectively, I believe we can do things that will benefit all of us. So, just to back up and tell you today, we are no different than you are and we look forward to working with you on the solutions to the problems. Thank you. (Applause)

Mr. Mabry: Thank you very much, Dave. I'll ask one question that I should have asked at the outset to give these people a frame of reference, how many miles, please?

Mr. Smoot: Indiana Hi-Rail, although we are classified as a short line, operates 250 miles on our system. It is broken down over five separate segments in three states.

Mr. Mabry: A true short line. Thank you so much. We move on now to a true Class I. Dave Kelly speaking for the Class I's, tell us please what you do with your spent cross ties.

Mr. Kelly First I would like to go into a little bit of the history of the problem. First the size of the problem. On our railroad we have approximately 21,000 miles of track and our rate of tie installation at the present time is in the vicinity of two million ties a year, so we have a fairly substantial number of cross ties to dispose of. Historically, over the past 20 years or so, the tie has been removed in three pieces on most of the Class I carriers with welded rail because of the problems with track disturbance. In the past few years, the advantages of the whole tie machinery has made taking the tie out in one piece much more feasible than it had been. So that is also an alternative. We use both methods at the present time on CSX.

As the short line, we have done several things with first the tie butt, and now the whole tie. Of course, first off, the most obvious thing was to do, as Dave Smoot said, absolutely nothing. And I would be less than honest to tell you that we don't do that anymore, because we have a lot of railroad, particularly in the southern portion of our system, where we take the tie stubs, stack them in a pile and shove them to the back of the right-of-way, particularly where we have a nice wide right-of-way. Because of the decay factor in the southern regions of our railroad, most of the cross ties are seriously decayed by the time they are removed anyway. So we stack them in the back portion and in about two years the vines cover them up. In about ten years the things have rotted away and no one knows they were there and we are ready for the next pile.

Unfortunately, on a lot of the railroads, particularly in the northern portions where you have wintertime, the ties don't decay that much and they stay in one piece. We don't have the benefit in the mountainous areas and heavy terrain areas of wide road beds and plenty of swamp lands to shove them into and that type of thing. The tie butts that are left are stuck in the ditches on the right-of-way and the next thing you know they are in the drainage facilities, blocking up the ditches, flowing up over the track and general nuisances all over.

It became quite apparent that this was not a very acceptable solution. Two major means of disposal were available at the advent of the mechanized tie replacement. First, we could burn the ties along the right-of-way. When I started on the railroad we did a great deal of that. I can remember one instance when I was assistant track supervisor in Pennsylvania, I had a track foreman whose duty every day was to burn piles of tie stubs. One day he went through a town that was about a mile long down in a little valley and he set every pile of tie stubs in that town on fire at three o'clock in the afternoon, hopped in his truck and drove just as far away as he could get. My phone rang off the hook all night long. (Laughter) If I had been living in that town I probably would have been in jail before the day was out. It soon became obvious that burning was not a very acceptable solution either and then as the regulatory agencies got involved, it ceased to become, particularly in the northeast, a viable alternative at all.

The other alternative that we used at that time was to bury the cross ties and we did this on most of the Class I roads that I have been associated with. We buried all kinds of tie butts and cross ties. The problem came when you started around on the second tie cycle. You went out and started digging a hole to bury the tie butts and what you found was that you had dug a hole with more tie butts in it. You had already filled them all and there was no place else to go.

Now we were really starting to get in to the crux of the problem at that point in time. So then, for a little while, we tried to chew up the ties. We tried the tie destroyer. Now, ideally, this sounded like a real good situation. We put this machine right in the tie gang and as we move down the track we just chew them up and spit out the stuff. Well, first off, we never got a tie destroyer developed that would run long enough or go fast enough to keep up with tie gang. Secondly, we seemed to have a nasty habit of leaving old dead spikes in them and tie plates on the ties and all this kind of stuff and every time that scrap metal would hit the tie destroyer, that was the end of it for three or four hours. Soon the mechanics and operators got tired of working on it and the next thing you knew it was 20 miles behind and not doing very much.

Then after the EPA and the ecologists really got into it, they decided that creosote mulch was killing the vegetation, which it did in some locations, and they didn't like the idea of having that in the towns and water. So we just never were able to get the tie destroyer concept fully working as an acceptable alternative and at least on CSX we have given up and scrapped all of those machines that we had. We no longer try.

Since the two easiest and most accessible methods of disposal were no longer at our fingertips, we decided that we must do something else. And in areas where the cleanup was essential, we ended up going out with a work train, crawlers, tandem ditchers and this type of equipment and loading the tie butts up to get them out of the drainage and haul them out to other locations. Or we would throw them over the bank or send them to a landfill, which became more rare. There is one landfill now that we can use in Alabama for cross tie disposal. So even though it is free for the company to use, it gets awfully expensive to ship a tie cross country from Chicago to Alabama or from Philadelphia to Alabama.

In the past few years we have moved on to the whole tie removal. What we do is try to take as many of our ties out in one piece as possible. We band the ties and arrange with contractors from all over the country for the sale and use of these ties in landscaping. Originally the landscape tie started out mostly with the abandonments. And a few of the big landscape tie suppliers bought up great numbers of cross ties in abandonments and did it that way. Now we try, and are reasonably successful, to sell the cross ties in bundles of 12 or 16 on the site where they sit to the contractors. Unfortunately, oftentimes we don't get much money out of them in that situation, and there are other situations where we do have to haul them to a location and pile them, which again requires the work train, the equipment and a great deal of expense for more people. I feel though, that soon the landscape market will start to dry up. Most of the ties that those fellows are buying as landscape ties still have a fair amount of form to them and will last a good long time around a garden and the wall. There are only so many gardens and walls and this kind of thing that people are going to be buying them for. You are talking in the vicinity of twenty to thirty million a year, generated all over the country. I don't know if that will remain a real good option in the future. There is a real concern on my part there.

There is one plan on CSX where it is going to try co-generation principle. It is experimental and we are very anxiously awaiting to see how that comes out. In general, though, the problem for the Class I railroad situation looking to the future is that the disposal of the spent wood cross tie will continue to be a problem. We have no easy answers; no panaceas at this point in time. I believe the landscape market, as I said, will soon be saturated and there remains a real opportunity for enterprising individuals to come up with new ideas and solutions to handle a problem that is as old as the railroads themselves. Thank you. (Applause)

Mr. Mabry: Dave Kelly, CSX. Dave Smoot told us he has on the order 250 miles. How many miles does CSX have?

Mr. Kelly: At the present time we are in the vicinity of 21,000 and, like most others, we are in the process of downsizing so that is liable to change any day. But right now it is about 21,000 route miles.

Mr. Mabry: Dave Kelly, do me a favor please? Don't overdo this downsizing business. Where in the world are the likes of Byron Hawkins and Bob Lance and the rest of the folks going to sell their railroad ties if you keep downsizing?

We have gotten through the conventional means of disposal. Now we are going to get into what used to be thought exotic. It is no longer exotic. It is a way of life. Frank Brogdon who is with Cedrite Technologies, Incorporated, of Kansas City, Kansas, will tell you about this amazing concept they have. Frank was formerly with Western Pacific and then Union Pacific. Frank.

Mr. Brogdon: Thank you, John. Good morning. At the risk of putting everyone to sleep first thing in the morning I have a few slides I would like to show you as to how we are handling the old ties.

Cedrite Technologies was created with a very strong consideration toward the scrap tie issue. It became apparent that burning, burying, and the usual practices of disposing of ties was a thing of the past and no longer going to be a viable means of getting rid of the ties.

The disposal issue is an issue and was one of the major considerations in the development of the Cedrite tie. Back in about 1972, Mr. Ed Potter, who had been fooling with the idea of coming up with some means of re-cycling waste out of the wood products industry was led by some railroad people to the notion of creating new cross ties out of old cross ties, recognizing again, that there was a major problem with disposal. With that his quest began and he developed a small prototype plant in Portland, Oregon, where he produced a good number of ties. By that I would say somewhere in the range of 3,000. They have been installed primarily on the Union Pacific and Santa Fe railroads but also on others, including the Canadian Pacific. Those ties, most of which are currently in track, have now been there as much as 12 years and are functioning well. That led to the financing of a plant and commitments from the two major railroads for new ties to be produced by us out of Kansas City for a couple of years. So two-thirds of our production for the next couple of years is committed to two major railroads.

There is a new plant which broke ground late last year and will start production, hopefully, next week. I was hoping I could come here and say we had just started, but another delay hit.

This is typical of the issue of scrap ties we are handling with a Prentice loader with a knuckle boom on it. Ties are brought in by the railroads, who are the customers for whom we will be producing new ties. For every two ties they ship to us, we produce and sell to them one new tie. As a result we are helping them dispose of their old product and we are creating something that is new and that we believe to be a premium cross tie. They are brought in on gondolas and unloaded with our knuckle boom. As you can see, behind there is a hopper unit which, when we are in production, will be loaded directly by the boom.

These are scrap tie piles. We now have roughly 100,000 ties on hand in Kansas City which is only a matter of about three weeks production when we get the plant in full operation.

We are stacking down the sides of two tracks. We have two service tracks for scrap. A third will serve the plant for inbound materials that may be required but most especially for outbound new ties.

This is the in-feed which we will anticipate loading directly from gondola cars into this hopper which will go into what we refer to as our chip-prep building. Inside the chip-prep building you see this conveyer unit which will orient the ties in the right direction, drop them into a vibrator conveyer where the excess ballast and dirt and such is shaken loose from them and they are moved on out toward the end of the building where they will go into the chippers. This is the internals of our primary hog which is nothing unique to the wood industry but it is very large, something in the way of 68 inches or so across. It is a pretty good sized hog. We have two of them. The ties leave the building on the conveying system, enter this hog, are chipped down to roughly the size of your fist, and then moved over to a second hog. This brings them down to about the size of a fingernail. In those processes, any metal that is left in the tie, end plates, s-irons, dowels, random spikes, are removed by magnet prior to that whole process. I apologize for going back, but in the vibrator conveyer system there is a metal detector and if we come across masses of metal, and I am speaking of tie plates, the spikes that are holding those plates will be removed along with the plate and/or the tie will be pulled right out of the system. But spikes, s-irons and things of that nature, go through the first hog intentionally and are then removed by magnet before going into the second hog.

The conveying system that you see is the conveying unit coming up into primary hog number one. Chips drop out of that one, cross over to hog number two, are chipped up and go back into the same building that they started from. The left hand portion of that building, about half of it, is chip storage. Inside that building and directly above is an in-feed conveyer which drops down out of this chain drive arrangement that is an outbound conveyer. It will take the chips out of this building and over to our primary manufacturing facility.

Ultimately, the chips go back out of that building and over to the primary building and into our forming line. At this point they come across the inside of that building at the upper level. They are blended in a continuously blending operation with resin. The moisture content of the material is read and if moisture is needed it is added. All of this is computer controlled. Process controls begin with the chain that we just saw in the other building. When it is activated everything starts moving. Every step in this building and that conveying system all work with process controls.

The procedure is simply that blended material is brought into three separate hoppers, ties are poured in nine foot long molds that weigh approximately a ton each and then are processed through a press where they are pressed down to seven inches. They move on to an oven where they are cured. They are then processed through a typical drilling and grinding unit, about the same that is used in the various treating plants. And you have a new tie. These are some of the prototype ties that were out on the Union Pacific in the very early stages of development of the product.

So as I say, when Cedrite is in full operation we will be producing 600,000 ties a year, which will consume roughly a million of your scrap cross ties. While that is kind of a drop in the bucket as to the total number of ties you need to dispose of we think it is a step in the right direction and it is a means for the railroads of getting some value out of recycling material that would otherwise be an expense to them to dispose of. Thank you for letting me share this with you. (Applause).

Mr. Mabry: Thank you very much, Frank Brodgon. You tell the story very well. So we have heard the two conventionals. We have heard one of the exotics which is no longer exotic. People keep saying it won't work, it can't be done and suddenly, there it is. We have another one that wouldn't work, that couldn't be done and suddenly there it is. Ray Ohlis, vice president Koppers Company, is going to tell the story of co-generation at Muncy, Pennsylvania. The Railway Tie Association created an environmental affairs committee a few years back and a gentlemen from Conrail was a charter member of that committee. He never did say this, but I think he was there for one reason only and that was to try to find a solution to the disposition of spent cross ties. This was been about eight years ago and at that time Conrail was paying about six dollars a tie to haul ties and to persuade the landfill operators to accept them. Now, landfills are filling up and who knows when the great white father in Washington is going to say, "You can't put any more spent cross ties in landfills". Well, given all of that and the fact that the answer wasn't immediately obvious, Conrail and the Pennsylvania Power and Light Company and Koppers Company entered into a joint venture to build a co-generation plant in Muncy, Pennsylvania. It is in place and it works and Ray Ohlis is going to tell us about it.

Mr. Ohlis: Thank you, John. Good morning. No one from Koppers these days can address a group without first responding to the obvious question: what is happening at Koppers? The Chemical Allied Products businesses are up for sale and that is ongoing. We have not released names of people interested in our business aside from the engineering group which has been spun off and is now called Chem Tech Consultants. Our Keystone Environmental group has been sold to Chester Engineers. There is a strict policy against releasing any names until the t's are crossed and the i's are dotted. I want to assure you that your requirements are at the top of the list, both the wood treating and wood preserving businesses. They will remain there now and in the future.

In February, 1987, construction of the Susquehanna co-generation plant was announced which involved three companies. They are Koppers Company which would build, operate and own the facility; Conrail which would supply the used cross ties and Pennsylvania Power and Light which would purchase electricity produced from the plant. The plant, located in Montgomery, Pennsylvania, near Williamsport, is adjacent to the Susquehanna Wood Treating Plant. Conrail will supply between 750,000 and 900,000 used cross ties annually as fuel to be burned in the 100,000 pound per hour boiler. Steam from the boiler will turn a ten megawatt generator to produce electricity, part of which will be sold to Pennsylvania Power and Light and also provide thermal energy to be used at the wood treating plant.

We believe this facility to be the first co-generation plant anywhere to use wood cross ties. It will establish a trend in cross tie disposal in harmony with local and national environmental energy goals.

Many months prior to the announcement of the plant, Koppers was working with the Pennsylvania Department of Energy, Environmental Resources, and other authorities to obtain the necessary permits. In order to construct and operate the plant, we had to obtain an air permit for stack and emission control equipment; a solid waste permit for operation of the boiler and storage of the used cross ties; a water discharge permit for boiler and cooling tower flow down; a permit to dispose of the ash in a county landfill; a permit from the Susquehanna River Basin Commission for water withdrawal from the ground; a co-generation license from the Federal Energy Regulatory Commission and a construction permit from the county.

Site preparation started in 1987 and actual construction started in August after all the permits were issued. The plant was started in late December, 1987, and completed in June, 1988. So, in essence, this facility was built in one year.

Let's take a quick look at how it operates.

This is a string of gondolas loaded with used cross ties switched into the treating plant. These are coming off the Conrail system, either from a tie gang operation or from ties that have been laying along the right-of-way. After the loaded gondolas are received at the treating plant, our in-plant locomotive switches them into the co-generation for unloading. We are receiving between 80 and 100 cars of used ties weekly to be unloaded. Once the tie cars are spotted a hydraulic loader will unload the ties and put them either into the co-generation plant or stack them for storage depending upon the load at the plant.

Our requirements to Conrail were that the used tie be solid and in one piece. The ties contain spikes, plates, dowels and irons which present no problems. To date the quality of the ties received has been excellent and we have only rejected a few cars in that they had contained switch ties or bridge material.

As I said earlier, if the ties are not needed at the plant they are stacked on an out-feed conveyer chain for moving to the used tie storage yard.

This is the tie storage yard. What you see here is about 130,000 ties. The solid waste permit allows us to store a maximum of 150,000 ties at any one time. This tie storage area is used as a surge pot. If we do not get cars in, we can pull onto there and if we have too many come in, we will put them out there. Likewise, in the wintertime when Conrail is not inserting ties, this will be the source of fuel and also, Conrail has agreed to store used ties.

This is the landing deck that feeds the elevators going into the plant. This boiler in the furnace has two cells and so, consequently, there are two lines feeding the ties into the building and into the boiler. At this time we are only handling eight foot six inch ties. In the future, at this plant, we will be able to burn three piece tie butts and beyond that we feel that we can design and build a system that also will be capable of handling other used material such as switch ties, bridge materials, crossing panels and piling.

This picture shows a tie being conveyed into the building. The two lines are feeding two cells. In this slide, you are up in the building looking down. When the tie comes into the building, it comes up to a total height of 30 feet and we have to do this so that we can get the right angle to insert the tie piece into the boiler. Once the tie is in the building, it is passed along a belt conveyer and is cut into two pieces. It is indexed ahead and is weighed prior to insertion into the boiler.

This is a tie going down a chute into one of the cells. The weighing of the ties is all computer controlled. The moving of the ties from the deck into the boiler is also computer controlled. There are no operators there. The weighing tells the boiler, based on the steam flow and pressure, more fuel or less fuel; all the controls are on the boiler.

This is a firebox just above the cells. The cells are approximately 15 feet off the floor and that shows the firebox. One hundred thousand pounds for our boiler. It was field erected. As I said earlier, the computer evaluates the wood entering the boiler, knows the steam demand and will automatically adjust the induction of air flow as necessary to maintain proper steam pressure flow and combustion conditions.

This is the turbine generator. It is General Electric. It has a ten-mega watt name plate. Under certain conditions it will put out 12.5 mega watts.

This is the computer control board. As I said before, the whole operation is completely computer controlled. The operators can start and stop motors from this panel. We have an analog system that we use to go back and recapture 72 hours to find out what has happened in the boiler. It completely runs the plant.

This is a small sub-station. This is the electricity from the turbine generator leaving the plant. It is a 69 KDA line that goes across the fields to the base of the mountain and ties in with the Pennsylvania Power and Light trunk line. Koppers was responsible for the construction of that line from our plant to their trunk line.

This is a shot of the whole facility. Right up against the building we have a heat exchanger that the hot gases flow through. The induction air is passed through there and heated to 400 degrees Fahrenheit. Then the gases pass on through a multi-cone, where the larger particles drop out, and then eventually to the electrostatic participator where the mini particles are dropped out. If you can see the plant in operation, there are no visible air emissions from the stack. The bends just below the electrostatic participator is where we put the ash. Amazingly, there is very little ash, a lot of tramp metal as we call it, spikes, plates, dowels and so forth.

We, at Koppers, feel the co-generation alternative is an excellent option to dispose of used cross ties. A used tie burned is gone forever whereas a tie buried in a landfill, along the right-of-way or just left to lay may have to someday be revisited. To put a project like this together takes three players: it takes someone who wants to dispose of used cross ties; someone who will construct, own and operate the plant; and an energy user, either steam, electricity or a combination.

We certainly appreciate the opportunity to tell you the Koppers story and stand ready to serve the industry. Thank you. (Applause)

Mr. Mabry: They tell me that Ray Ohlis is something, if not a genius, then a near genius, in this mechanical business and we are just delighted to have him here today to tell that story.

You four panelists, if you would be good enough to give your papers to the man at the end of the table, it will make the transcriber's job a bit easier, when they get ready to transcribe the minutes of this meeting.

Thank you, Dave Smoot, Dave Kelly, Frank Brogdon and Ray Ohlis. We, at the Railway Tie Association, appreciate the opportunity to tell our story. We hope you found it interesting and even helpful. A wood railroad tie is just not allowed to quit. It goes on and on and on and if any of you happen to live in the area of the Cedrite operation or the co-generation plant, you will appreciate this increasingly in the months and years ahead. Thank you, gentlemen. Good luck and God bless. (Applause)

President Snyder: Thank you, gentlemen, for a very interesting cross section of our problems and some solutions for our tie problems.

At this time I would like to turn the podium over to Byron Burns who will introduce our next speaker. Byron.

Mr. Burns: Thank you, President Snyder. First of all I have a brief announcement for the benefit of those of you not present at yesterday's joint session, I would like you to note the change in tomorrow's schedule. The presentation entitled ''Explosive Demolition of Structures'' was originally scheduled for 9:25 a.m. on Wednesday. However, Mr. Clark Juenette, who was going to make the presentation, is unable to attend the conference. Instead, there will be a presentation on the use of roller-compacted concrete. Mr. Brian T. Bock of the Portland Cement Association, will make the presentation.

At this time it is my pleasure to introduce our next speaker, Mr. Ben Jezek of the Victor Equipment Company. Mr. Jezek has been involved in the oxy-fuel equipment industry for 22 years, holds several equipment patents and is considered to be an expert in that field. May I now present Mr. Ben Jezek.

MAINTENANCE AND SAFE USE OF GAS WELDING EQUIPMENT

Ben F. Jezek

National Accounts Manager
Victor Equipment Company

Thank you, Mr. Burns. At this time I would like to say thanks for the opportunity to address this group. What I am going to be talking about is something that a lot of times we take for granted, the oxy-fuel process that is used quite extensively throughout the railroad industry. But we just kind of consider that everybody knows everything about it and how it works.

There are a number of inherent hazards in the use of oxy-fuel welding and cutting apparatus. It is therefore necessary that proper safety and operating procedures be understood prior to the use of such apparatus. A thorough understanding of the proper safety and operating procedures will minimize the hazards involved and add to the pleasure and efficiency of your work.

The Work Area

Heat-resistant shields should be used to protect nearby walls or unprotected flooring from sparks and hot metal.

Adequate ventilation is required to prevent the concentration of oxygen/fuel gas and/or toxic fumes. It is important to remember that oxygen itself will not burn, but the presence of pure oxygen will serve to accelerate combustion, and cause materials to burn with great intensity. Oil and grease in the presence of oxygen can ignite and burn violently.

Work benches or tables used during oxy-fuel processes must have fireproof tops. Fire bricks are commonly used for topping these surfaces and supporting the work.

Oxygen and fuel gas cylinders must be chained or otherwise secured to a wall, bench, post, cylinder cart, etc., to protect them from falling and to hold them upright.

Protective Apparel

Protect yourself from sparks, flying slag, and flame brilliance at all times. Select goggles with tempered lenses shaded four or darker to protect eyes from injury and to provide good visibility of the work.

Wear protective gloves, sleeves, aprons and shoes to protect skin and clothing from sparks and slag. Keep all clothing and protective apparel absolutely free of oil or grease.

Fire Prevention

Inspect oxy-fuel apparatus for oil, grease or damaged parts. Do not use the oxy-fuel apparatus if oil or grease is present or if damage is evident. Have a qualified repair technician clean and/or repair the oxy-fuel apparatus before using it.

Never use oil or grease on or around any oxy-fuel apparatus. Even a trace of oil or grease can ignite and burn violently in the presence of oxygen.

Keep flames and sparks away from cylinders and hoses. Flying sparks can travel as much as 35 feet, so move combustibles a safe distance away from areas where oxy-fuel operations are to be performed.

Use approved heat-resistant shields to protect nearby walls, floors and ceilings. Have a fire extinguisher of the proper type and size in the work area and inspect it regularly to ensure that it is in proper working order and know how to use it.

Use oxy-fuel equipment only with the gases for which it is intended. An acetylene cylinder valve shall not be opened more than approximately one and one-half turns and preferably no more than three-quarters of a turn. Keep the cylinder wrench, if one is required, on the cylinder valve so the cylinder may be turned off quickly if necessary. For all gases except acetylene: open the cylinder valve completely to seal the cylinder back seal packing. Never test for gas leaks with a flame. Use an approved leak-detector solution. When work has been completed, inspect the area for possible fires or smoldering materials.

Industrial Gases

Oxygen

The presence of oxygen is required to support any burning process. It is, therefore, necessary that oxygen be combined with a "fuel" gas to produce the desired operating flame. Oxygen itself is not flammable. However, the presence of pure oxygen will drastically increase the speed and force with which burning takes place. Its presence can turn a small spark into a roaring flame or explosion.

Oil and/or grease in the presence of oxygen becomes highly flammable or explosive. Oxygen must never be allowed to contact oil, grease or other petroleum-based substances.

Oxygen is ordinarily supplied in standard drawn steel cylinders. The 244 cubic foot cylinder is most commonly used, but smaller and larger sizes are available. Full oxygen cylinders are normally pressurized in excess of 2,000 pounds per square inch. Oxygen cylinder contents can be determined by reading the high pressure gauge on the regulator when in use. For example, half the full cylinder pressure rating indicates half the volume (c/f) of oxygen remaining. The maximum charging pressure is always stamped on the cylinder.

Due to the high pressure under which oxygen is bottled, cylinders must always be handled with great care. The potentially violent reaction of oil, grease or all other contaminants in the presence of oxygen cannot be over stressed.

Serious injury may easily result if oxygen is used as a substitute for compressed air.

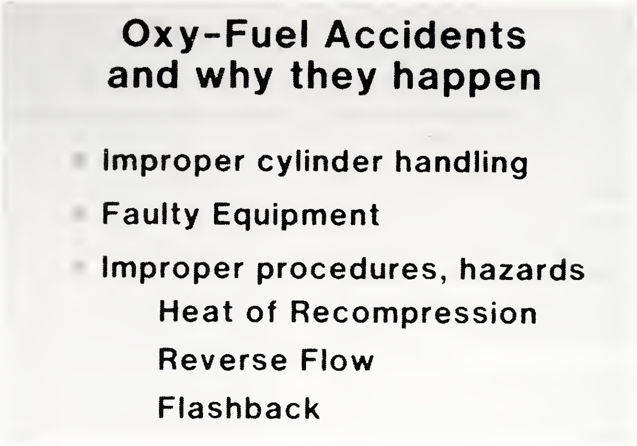
Never use oxygen in pnuematic tools; in oil preheating burners; to start internal combustion engines; to blow out pipelines; to dust off clothing or work area; to create pressure; for ventilation. Use oxygen only in oxy-fuel welding, cutting and heating applications.

Valve outlet and inlet connections:
CGA 540 up to 3000 psig
CGA 577 up to 4000 psig
CGA 701 up to 5500 psig

Fuel Gases

Acetylene

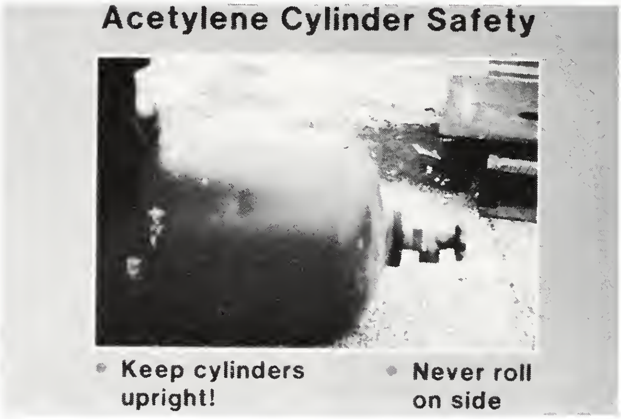
Acetylene is a compound of carbon and hydrogen (C_2H_2). It is a versatile industrial fuel gas used in cutting, heating, welding, brazing, soldering, flame hardening, metallizing, and stress relieving applications. It is produced when calcium carbide is submerged in water or from petrochemical processes. The gas from the acetylene generator is then compressed into cylinders or fed into piping systems. Acetylene can become unstable when compressed in its gaseous state above 15 psig and therefore cannot be stored in a hollow cylinder under high pressure the way oxygen, for example, is stored. Acetylene cylinders are therefore filled with a porous material creating, in effect, a "solid" as opposed to a "hollow"



Oxy-Fuel Accidents and why they happen

- Improper cylinder handling
- Faulty Equipment
- Improper procedures, hazards
  - Heat of Recompression
  - Reverse Flow
  - Flashback

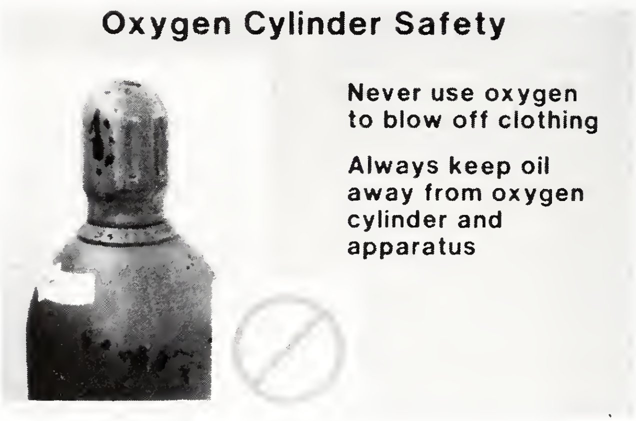
No. 4-0003



Acetylene Cylinder Safety

- Keep cylinders upright!
- Never roll on side

No. 4-0005



Oxygen Cylinder Safety

Never use oxygen to blow off clothing

Always keep oil away from oxygen cylinder and apparatus

No. 4-0010

cylinder. The porous filling is then saturated with liquid acetone. When acetylene is pumped into the cylinder it is absorbed by the liquid acetone throughout the porous filling and is held in a stable condition. Filling acetylene cylinders is a delicate process requiring special equipment and training. Acetylene cylinders must therefore be refilled only by authorized gas distributors. Acetylene cylinders must never be transfilled.

Regulators

Regulators are attached to the cylinders or manifolds by their "inlet connections". All inlet connections conform to specifications and standards set by the Compressed Gas Association (CGA) and are marked with an identifying CGA number. CGA numbers identify the cylinder valve/gas service for which that inlet connection is designed. Examples: CGA 510 has been designated for standard fuel gas cylinder connections such as acetylene, methyl acetylene and propane. CGA 540 connections are designated for oxygen service only. Fuel gas inlet connections usually have lefthand threads. Those with lefthand threads also have a "V" notch around the inlet nut to further designate the connection for fuel gas service. All oxygen connections have right-hand threads.

Always take care to keep the regulator free of oil and grease. Oil and grease should be removed chemically by a qualified repair technician. Never use oil or grease on the regulator, cylinder or manifold connection. Do not change the inlet connection on a regulator in an attempt to use the regulator for a different gas service.

Pressure Adjusting Screw

The regulator adjusting screw controls the delivery pressure of the gas to the hose. As previously stated, the regulators function to reduce high supply pressures to a suitable working pressure range. When the adjusting screw is turned clockwise, the regulator will allow gases to flow through the regulator to the hoses and to the torch. The threaded adjusting screw applies mechanical force to a spring and diaphragm which control a pressure valve on the regulator. If the adjusting screw is turned fully counterclockwise, tension on the spring is released and the regulator will not allow the gas to flow.

Pressure Gauges

The high pressure gauge indicates the cylinder or supply pressure entering the regulator. The low pressure gauge indicates the delivery pressure from the regulator to the hose. All gauges are precision instruments and should be handled with care.

Outlet Connections

Welding hoses are attached to the regulator outlet connections. Fuel gas regulators have left-hand threaded outlet connections to mate with the left-hand hose connections and have a "V" notch around the outlet connection to further designate the connection for fuel gas service. Oxygen regulators have right-hand threaded outlet connections to mate with the right-hand hose connections.

Relief Valve

The relief valve is designed to protect the low pressure side of the regulator from high pressures. Relief valves are not intended to protect downstream equipment from high pressures.

Do not tamper with the relief valve or remove it from the regulator.

Hose

The welding hose transports low pressure gases (maximum 200 psig) from the regulators to the cutting or welding torch. Proper care and maintenance of the hose will assist the operator in maintaining a safe, efficient shop or work area.

Hose Construction

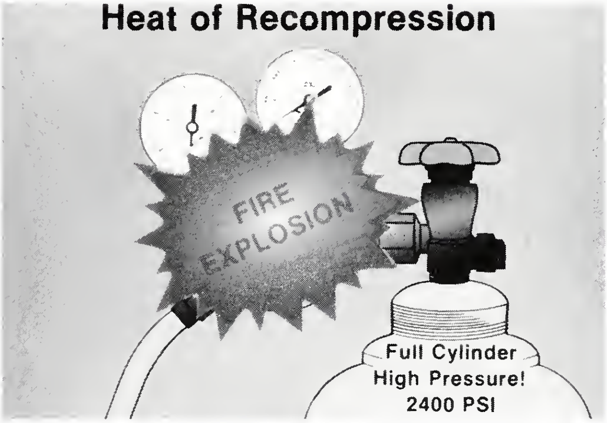
Industrial welding hose is usually color-coded for gas service identification. Oxygen hose is usually green and fuel hose is red. The hose walls are constructed of continuous layers of rubber or neoprene material over a braided inner section. All approved domestically fabricated type VO grade RM hose is flame "retardant". It will burn, but will not support a flame if the heat source is removed.

Torch Handle

A torch handle is essentially a set of gas tubes with control valves. One tube and valve controls the fuel supply and the other tube and valve controls the oxygen supply. The torch handle is not designed to mix the gases for oxy-fuel processes. The cutting or welding apparatus attached to the handle mixes the oxygen and fuel gases, while the handle is a means of control for the gas supply. It is strongly recommended to install accessory check valves to any torch not equipped with internal check valves. (NOTE: The purpose of an internal valve is to

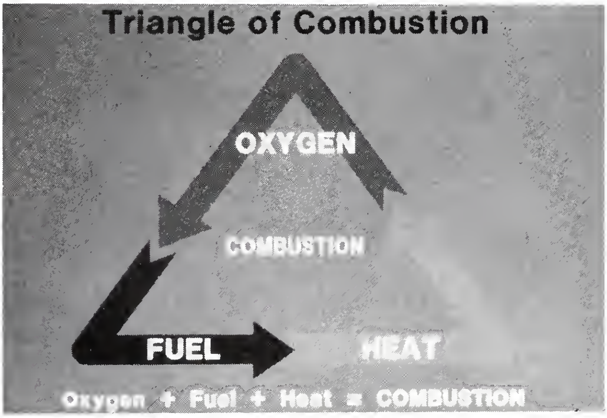
Oxy-Fuel Hazards

No. 4-0016



Heat of Recompression

No. 4-0029



Triangle of Combustion

Oxygen + Fuel + Heat = COMBUSTION

No. 5-0030

reduce the possibility of reverse flow gas. It is not intended to act as a fire stop!)

Cutting Attachment

The cutting attachment functions as a convenient and economical approach to cutting operations where the frequency and/or application does not require a torch designed strictly for cutting. When connected to a torch handle, the cutting attachment functions as a cutting torch and provides the operator with a wide range of cutting capabilities.

Mixing Chamber Tube

Fuel and oxygen must ultimately be mixed to produce the desired preheating flame. To accomplish the necessary mixing of gases, oxygen and fuel are fed into a "mixing chamber" located in the forward portion of the cutting attachment mixing chamber tube. Oxygen is directed to the mixer from the "inner oxygen tube" while the fuel gas is drawn from the exterior cavity of the attachment lower tube around the mixer. Mixed gases then flow through the preheat orifices of the cutting attachment head and into the preheat orifices of the cutting tip.

Cutting Oxygen Lever and Tube

The cutting oxygen lever is located above the body of the cutting attachment. When the oxygen control valve on the torch handle is open, depressing the lever will allow cutting oxygen to flow through the upper tube of the cutting attachment head. The upper oxygen tube is designed to allow the maximum supply of oxygen to the cutting operation and to provide structural strength by the utilization of high-strength tubing.

Cutting Attachment Head

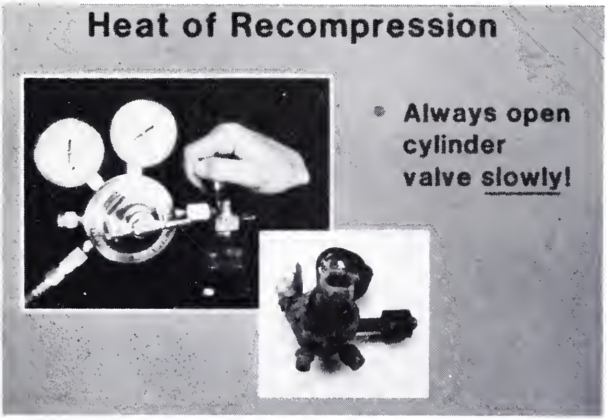
The cutting attachment head is designed to allow the cutting oxygen and the mixed preheat gas to stay separated in the cutting operation. The exterior of the torch head is threaded and the interior of the head is tapered. The internal taper of the head is stepped so the preheat gases can feed the cutting tip through the exterior orifices and the cutting oxygen can travel uninterrupted through the center port of the tip to the heated base metal. The exterior threads on the head allow a tip nut to compress a cutting tip into the tapered head, thus creating a firm metal-to-metal seat.

Cutting Tip

Cutting tips are available in a wide variety of configurations and sizes. Cutting tips keep the preheat gas mixture and cutting oxygen stream separated and provide flame characteristics needed for a particular cutting application. Tips are sized according to the thickness of metal they can cut.

The tapered end of the tip is machined to fit into the cutting attachment head. A tip nut secures the tip into the head, and the tapered surfaces form a metal-to-metal seal. Both head and tip tapers should be inspected frequently for signs of damage or wear.

A damaged seating surface on either the tip or the head can create a dangerous condition and result in a fire or backflash that may damage the cutting attachment. If the seating surface of a tip becomes damaged, don't use it. Discard the damaged tip. If the head requires repair, take the torch to a qualified repair technician.



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Preheat Orifices and Oxygen Orifices

Cutting tips are subjected to much abuse in cutting operations. Molten metal can splatter and stick to the cutting tip, clogging or obstructing the passages through which the gas must flow. Splatter can be removed from the tip orifices with small round files (tip cleaners). Repeated cleaning, however, can affect the flame configuration and render the tip unsuitable for precision work.

Multi-flame Heating Nozzle

The multi-flame heating nozzle is basically a large welding tip. The cone end coupling nut and mixer assembly are similar in design to a welding tip. The multi-flame tip has been machined to utilize numerous flames. This provides additional heating capacity for heavy heating applications.

Never starve or choke a multi-flame heating nozzle. This will cause overheating of the head, and a backflash may result. Should a backflash occur (flame disappears and/or a hissing sound when the flame burns inside the nozzle), immediately turn off the oxygen valve on the torch handle, then turn off the fuel valve. Allow the nozzle to cool before attempting to reuse. If a backflash or burnback occurs, have the apparatus checked by a qualified technician before reusing.

Thank you very much, gentlemen, for the opportunity to address you on this subject. (Applause)

President Snyder: Are there any questions of Mr. Jezek? This entire presentation will be in both the Roadmasters and Bridge and Building Proceedings and I certainly recommend that all of you supervisors go over this closely with all of your people and make sure they understand it. Mr. Jezek, thank you again.

At this time we will take a break and reconvene in fifteen minutes, with the Roadmasters continuing their session here in the Red Lacquer Room and the B&B session being held in the State Ballroom. This joint session is now adjourned.

Adjourn

TUESDAY MORNING SESSION
11:00 a.m.

President Lewis: The second session of our 93rd conference is now in session.

At this time I would like to turn the program over to Steve Lipkus, sponsor of this morning's special subject presentation. Steve.

Mr. Lipkus: Thank you, Don. Our next presenter is Tom Dunn. Tom worked for several years as a carpenter before someone misled him to believe that he could actually make more money as a civil engineer. So he enrolled at the University of Wisconsin at Madison and, in 1977, graduated from there with a Bachelor of Science Degree in engineering. He began his railroad career as a B&B supervisor for the Chicago and North Western, moving on to become a project engineer on that railroad's western coal line construction. From there he was promoted to construction engineer here in Chicago and on to manager of structures for the suburban division. Tom is presently the bridge engineer for the C&NW and is a registered professional engineer in the state of Wisconsin. Ladies and gentlemen, it is my pleasure to present Mr. Tom Dunn.

SPECIAL SUBJECT NO. 3

Performance of Precast Concrete Ballast Deck Slabs

Chairman:	T. V. Dunn, Br.Engr., C&NW, Chicago IL
Vice Chairman:	D. G. DeBerg, Engr.Rail-Fld., AT&SF, Topeka KS
Committee:	B. T. Burns, Asst.Mgr.Strs., AT&SF, Topeka KS W. H. Nelson, Mgr.M/W Trng., BN, Overland Park KS S. Lipkus, Br.& Str.Mtce.Engr., CN, Edmonton ALB H. L. Davidson, Engr.B&B, CSX, Corbin KY C. E. Thompson, B&B Mstr., CP, Burnaby BC J. T. Kapp, Proj.Mgr.Constr.,Conrail,Philadelphia PA R. A. Tallent, Proc.Engr.Strs., NS, Atlanta GA R. C. Karsten, Gn.Fmn.,B&B Util., SLSW, Hutchinson KS J. J. Horney, Prog.Engr.B&B, UP, Omaha NE

Additional materials gratefully received from Amtrak, BC Rail, D&RGW, Guilford Transportation, GTW, IC, SP, Soo Line, Wisconsin Central.

Introduction

Railroad bridges carry tracks across them by open deck or ballast deck methods. The open deck carries the tie directly on a supportive bridge member. The ballast deck carries the load from the tie through ballast, into the ballast retaining component and then onto the supportive bridge member. Both methods have been used successfully for many years.

Several ballast deck methods are in use throughout the industry. The box arch is one form of spanning a distance while keeping a ballast section. The wooden trestle with ballast deck was used extensively and is still in use in many areas. Prestressed concrete spans carrying ballast sections are an increasingly popular method for bridge construction having largely replaced conventionally reinforced concrete spans. Steel spans carry ballast decks that retain and hold the ballast with wood, steel, and/or concrete.

Some railroads prefer to use timber ballast decks mainly when converting an open deck bridge to ballast deck. Another alternative has been to convert to a steel ballast deck if a smaller track raise is desired.

Several major railroads use precast spans which incorporate a ballast deck in the design. T-beams, box girders, and other designs are spanning from 14 to 78 feet very economically.

The variety of ways different types of steel spans can be used is multiplied by the number of ways the deck slab can interact with the span. Steel decks can be used with steel spans, and another is the composite concrete deck usually cast-in-place over steel studs. The precast concrete slab is our topic of discussion.

The oldest concrete slabs were conventionally reinforced using a variety of waterproofing at the joints. They have required re-waterproofing, and some have been changed out because of their condition or the need to repair the supporting bridge span. Once removed for steel repairs to the cover plate and/or top flange some railroads have chosen to replace the slabs.

Modern precast concrete ballast deck slabs.

Sample Statistics from 17 Railroads

	Railroads Without	 With
Precast concrete ballast deck slabs	3	14
Standard design for ballast deck slabs	9	8

Age of Slabs in Use (in years)	Number of Railroads
0-3	1
3-7	1
7-15	3
15-30	4
30+	5

Oldest slabs were reported by Conrail (Penn Central), 1915, and by C&NW, 1917.

Eight railroads are currently using precast concrete ballast deck slabs in new construction; nine reported they are not.

Disadvantages as cited by major railroads:

1. Too heavy to handle.
2. Too difficult to waterproof.
3. Installation of slabs onto existing structure may result in complicated grade raises.
4. Slabs are easily damaged in shipment.
5. Bearing surfaces of the slabs on steel are irregular.
6. More time is required for bridge replacement.
7. Higher initial costs.
8. Joints develop leaks over long period of time.
9. Leaking joint areas cause the steel under them to deteriorate or to shorten the paint cycle requirements.
10. Leaking joint areas tend to have spalling concrete and other concrete weathering-type deterioration.
11. Slab decks make bridge inspections more difficult.
12. Top flanges of the steel span rust, and it is difficult to determine the extent.
13. Top areas of steel spans are poorly ventilated which increases corrosion in wet conditions.
14. Top flanges and top lateral bracing are not accessible for cleaning and painting.
15. Epoxy-type materials used in bonding limit work to certain temperature ranges, typically when ambient temperature is 50 degrees Fahrenheit or above, due to the retard set. They also require a six-hour traffic-free window for the epoxy to reach design strength.
16. Rivet heads on built-up girders make installations difficult.

17. Generally one is unable to stockpile slabs for emergencies due to the various holes tie-downs require.

Advantages reported by major railroads:

1. Subsequent track alignments are much easier made with conventional track surfacing gangs and equipment.
2. Impacts and other forces on bridges are lessened by better alignment and transition.
3. Costly bridge ties and anchoring systems are eliminated.
4. Existing track maintenance production gangs can work through bridges at same cost per foot.
5. Practically maintenance free.
6. Less vulnerable to damage from derailments.
7. Low maintenance cost.
8. Long life expectancy, longer than wood ballast decks.
9. Easily installed, faster than wood ballast decks.
10. In comparison to ballast timber decks, the slabs provide a water-tight deck. This lessens corrosion and the wet conditions found in this poorly ventilated area.
11. Epoxy grout used between slabs and steel and between the slabs themselves create a monolithic, water-tight span. This also contributes to the strength of the span versus other systems. The gained strength with this method can reduce top cover plate and top lateral bracing replacement requirements.
12. Good water-tight surfaces on concrete ballast decks extend the painting cycle.

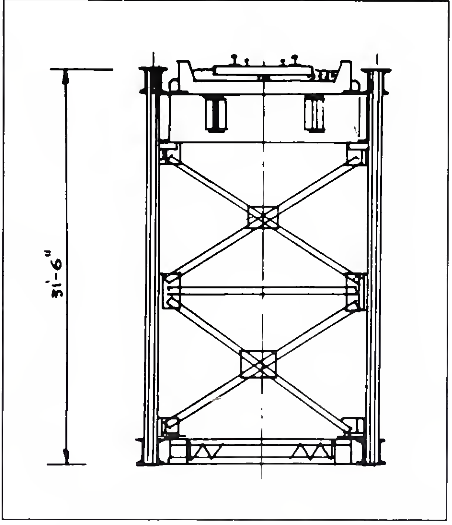
Design

All slabs are being made for modern day traffic using AREA guidelines. Dead loads include the slab itself (typically four to six ton), ties, rail, walkway, railings, and the ballast. Though normally installed with about six inches of ballast below tie, dead load considerations should assume two feet of ballast. Live loads used are Cooper E-80 with diesel impact. Specifically, AREA Chapter 8 will guide the engineer through the design considerations. The engineer must be sure to consider handling of the slabs during manufacturing, transport, and installation. Good drawings show installation, bearing, joint, waterproofing, and other details.

Many railroads prefer prestressed concrete slabs rather than conventionally reinforced. The prestressed slab achieves a minimal depth and more crack-free slabs under service loads. Prestressing also increases durability during handling and installation, generally resulting in a better product.

Lifting hooks or other specific facilities for handling are cast into slabs to ensure that lifting is done at the proper location. Storage, transport, and erection of precast slabs should comply with recommended practice to avoid damage to the slabs. Improper construction techniques can contribute to poor product performance just as poor manufacturing can.

Ballast stops can be cast into the slab or bolted on later. Prestressed slabs usually have the stops added later. Performance seems to be satisfactory with either method. Derailments sometimes damage the curb, and being able to change out segments is an advantage, though repairs to monolithic slabs are neither complicated nor time consuming.



Deck slabs used with truss.

Waterproofing and Drainage

All slabs must have waterproofing and drainage properly handled. Drainage of the decks is accomplished with floor drains, drains through the ballast curbs, or by spaces intentionally left between ballast stops and deck. It is evident that particular attention needs to be given at the time

Sixty year old precast ballast deck slabs on 70 MPH main line carrying 400 million gross tons annually.

of construction to providing a good waterproofing system on the concrete surfaces under the ballast. This limits deteriorating effects of water on the concrete and the supporting steel. Almost all waterproofing systems have a layer(s) of membrane overlaid with a layer(s) of protective material. The protection prevents ballast from damaging the membrane.

Of the railroads that had precast ballast deck slabs and no longer use them, the failure of waterproofing was cited most often. It is important to note that most of the roads which are not using the slabs have not used them in the last 25 years. Those that are still using slabs feel confident about their waterproofing details and have continued to use slabs for many years. Keeping abreast of modern materials and incorporating them into design seems to be enough reason for using slabs based on their other advantages.

One waterproofing method now being used is a coating of adhesive cement followed by one or two layers of flexible membrane, covered by one inch thick protection board. Joint details require more attention, and several railroads express satisfaction with their methods. The age of some waterproofed joint details currently being used is between 15 and 20 years old, and they still perform well. Others are less than 10 years old and must perform longer to judge the quality of the joint. The possibility exists that railroads will be willing to accept certain problems of slabs, when advantages are weighed against disadvantages. Eventual problems with joints have so discouraged some railroads with 70 year old structures that they do not use similar designs. Railroads with 15 year old slabs and less report no known problems with waterproofing.

Manufacturing

Tolerances in slabs and other precast or prestressed components are set by recommended practice documents such as the ''Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products'', by the Prestressed Concrete Institute of Chicago, Illinois, which exist to serve the owner and manufacturer of quality products. Material costs of precast, concrete slabs run from $125 to $250 per linear foot. Delivery can be made in about 45 to 90 days from order. Total cost per track foot of installed slabs is approximately $500 to $800.

Installations

Equipment required for installing and maintaining concrete ballast deck slabs is generally available on most railroads. Distinct lifting points on the slabs make handling and carrying easy with simple slings. Since track panels are usually involved, a medium-sized crane can handle the four to six ton slab load readily. Generally, other activities at the site such as setting the steel will have sized the equipment sufficiently for handling the slabs.

Fastenings for slabs often resemble those currently being used for ties on open deck structures. Problems and solutions with fasteners are similar to those with ties. Offset shoes, clips, and other arrangements sometimes become loose, but good quality control at time of construction minimizes the problems.

One exception to hold-downs is to notch the slab on the underside to keep it from moving laterally. The slabs are not mechanically fastened but rest on the girders by their weight alone. This has been used on both two or four girder systems.

The slabs, or concrete pans as they are often referred to, can rest on rubber pads that are attached to the top of the steel by adhesives. The adhesive can also be placed at the rubber pad concrete interface. The pans can also rest on a one-half to one and one-half inch layer of epoxy grout that covers surface irregularities. This layer of grout can also create a bond that contributes to strengthening and waterproofing.

The time required to work with precast concrete ballast deck spans is generally only a few hours more than for conventional open decks. The size of the job and often the epoxy materials do require certain minimum times. A six-hour window has been quoted often by major railroads as an estimated time requirement.

Waterproofing is one of the most important steps during installation. The subsequent performance of the slab will most likely be dependent on the quality execution of this step during installation. Good details, procedures, and materials will make this job quicker and easier for the field crews. Gaps are covered with steel plates at points between spans. These plates and other joints between slabs are then waterproofed with the railroad's own unique systems. All systems must account for some movement between spans or between spans and the abutment. The joints between slabs are either bonded with grout or filled with asphaltic mastics. Some extensive specifications and other information are available on waterproofing. Waterproofing was a Special Subject Report in 1978. The AREA Manual of Recommended Practice also includes several methods.

Typical Problems and Solutions

Bearing pads between deck slab and steel support (top flange) were working loose. Now pads are glued to concrete and steel using an epoxy adhesive.

Joints have leaked on older slabs which caused spalling concrete and deteriorated steel. Repairs to these areas after 50 to 60 years of service solve the problem. The repair consists of steel and concrete repair as well as rewaterproofing the joint. Sometimes the entire bridge is rewaterproofed if time permits.

Hairline cracks have appeared in some prestressed pans before installation or immediately thereafter. These may be due to shrinkage, handling, or deflection due to slightly uneven bearing surfaces. Cracks can be repaired by drilling into the cracks, installing ports, and injecting epoxy until the cracks are filled. No repairs have been made to some cracks which have been noticed after installation. After monitoring for several years, there appears to be no detrimental effect. Good waterproofing probably lessened the effects of the cracks. The cracks generally develop transverse to the track (parallel to the prestressing strands).

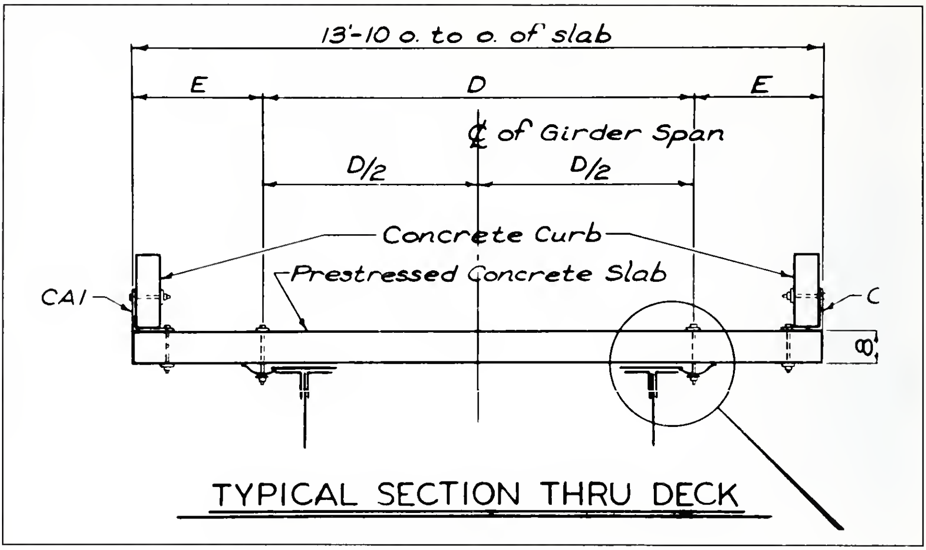
Drainage is provided for in the slab design. Fouled ballast eventually leads to plugged drains. The removal of the fouled ballast and replacement with new solves this problem. This can be done with total replacement across the bridge or minimally at the drain location.

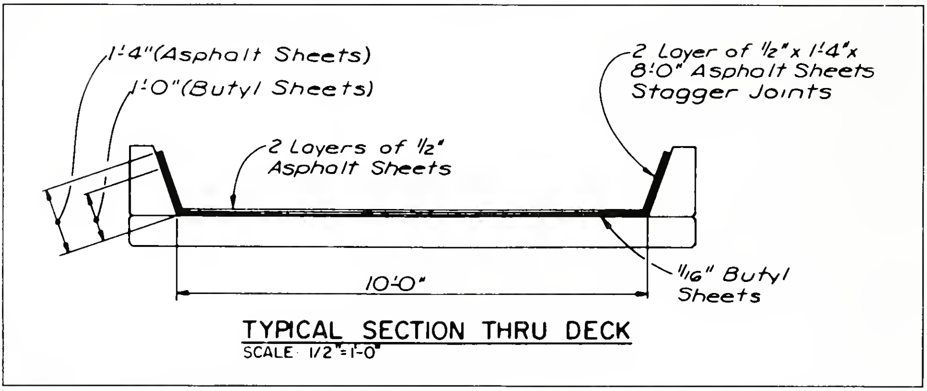
Ballasted bridges over highways always have the potential for spillage of rocks to the highway below. As long as attention is paid to this potential liability by track forces, the hazard is minimized. The ballast deck is advantageous over roads by preventing most other debris from dropping onto the highway.

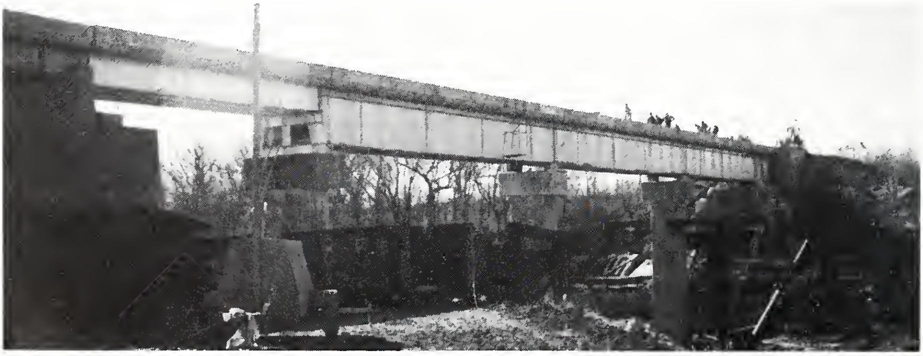
Asphaltic coatings and mastics applied directly on the concrete deteriorated more rapidly than membranes with protection boards. They must be changed out or the effects of water leaking or leaching onto the steel must be tolerated.

Conclusion

Precast concrete ballast slabs are in use on most railroads. Several stopped using them when problems arose from leaking or leaching decks which accelerated steel deterioration. The remaining railroads continued to use the slabs and kept changing designs to deal with problems as they arose. Other railroads have recently




1'-4"(Asphalt Sheets)
1'-0"(Butyl Sheets)
2 Layer of 1/2" x 1'-4" x 8'-0" Asphalt Sheets Stagger Joints
2 Layers of 1/2" Asphalt Sheets
10'-0"
1/16" Butyl Sheets
TYPICAL SECTION THRU DECK
SCALE 1/2"=1'-0"



Recent installation of precast concrete ballast deck slabs.

started using slabs and feel confident with their designs.

The amount of maintenance required for 15 to 20 years is minimal. Performance is great. After 20 years, some problems have arisen in old designs but new designs have dealt with those deficiencies. Some bridges have been in service almost 65 years with no maintenance. Time available for installations, costs, and durability are all factors that need to be weighed when choosing bridge alternates. Those railroads that are using precast concrete ballasted deck slabs are proud and confident of their performance. Are there any questions? If not, thank you. (Applause)

President Lewis: Thank you, Tom, for a very interesting presentation. The next item on our program will be presented by Byron Burns. Byron.

Good performance of slabs on coal line.

Mr. Burns: Thank you, President Lewis.

It is my pleasure to introduce our next speaker, Mr. Roger Fitch of the Union Pacific Railroad Company. Mr. Fitch was born and raised in Portland, Oregon. He received his Bachelor's Degree from Stanford University. He began his railroad career with the Union Pacific by working on a survey party one summer while in college. Upon graduation, he returned to the Union Pacific as a surveyor. Later, he transferred to Omaha where he served in various capacities in the bridge and architectural departments until appointed fire protection engineer in 1978. The job title was upgraded to manager fire protection in 1987, which is the position he currently holds.

As manager fire protection, Mr. Fitch directs and coordinates all Union Pacific fire prevention and protection programs and serves as technical advisor on fire related matters to all his company's activities on the 21,000 mile system that covers 20 states.

Additionally, Mr. Fitch is currently chairman of the National Fire Protection Association's Railroad Section which represents fire protection professionals in the railroad industry. He was editor of the chapter on ''Railroad Fire Protection'' in the current edition of the National Fire Protection Association publication, ''Fire Protection Handbook''. May I now present Mr. Roger Fitch.

FIRE SAFETY

Roger K. Fitch

Manager Fire Protection
Union Pacific Railroad Company

Thank you. It is a pleasure to be here, and I recognize several faces in the audience. I have worked with B&B people for a long time. A good part of my job is doing things that involve B&B people, and it is a pleasure to be able to stand in front of you and share a little of the information I have gained over the years. One of the things that the Railroad Section of the National Fire Protection Association puts out is our annual fire loss statement for the industry. I have a few copies available for anyone who is interested. It is the 1987 results of the entire railroad industry for fire protection. I will tell you more about the National Fire Protection Association later. Keep the name in mind.

Today I am here to tell you about fire safety. This is a broad topic, and there is no way I can cover the entire spectrum of fire safety in a half-hour session.

Fire safety is the result of many things properly done, consistently. So, for my half hour, I am going to talk briefly about each of six fire-related topics, all critical to achieving the result of fire safety, and to give each of you at least a basic appreciation of just what fire safety is.

First, a little history; second, an illustration of the scope of fire safety in its broadest sense, but keyed to the B&B environment; third, some fire prevention principles and techniques; fourth, fire equipment and systems you should be aware of; fifth, fire equipment and system maintenance requirements; and sixth, help and guidance that is available to you.

History

First, a little history of the railroad fire situation. Railroad fires, many think, are pesky happenings that should have been "fixed" long ago. However, in spite of our success at putting men on the moon, the railroad fire is still with us. So is the common cold! So are flies and mosquitoes!

We Americans did not invent railroad fires. They, along with railroads that cause them, were imported from England in the early 1800s. Listen for a minute to an eyewitness account by one, Angus Sinclair, of a very early American railroad fire incident, the first passenger train trip in the State of New York:

"The original intention was to burn anthracite in the firebox of the engine, but a few experimental runs had proved that anthracite would not generate steam fast enough, so it was determined to burn pitch pine. There was no spark arrestor, so the force of the exhaust threw out a volume of black smoke freely mixed with sparks, coal, cinders, and lumps of half-burned pine. The sparks found their way into the eyes and ears of the passengers, down their necks and into every crevice in their clothing. Those who carried umbrellas raised them to ward off the fiery downpour; but these soon took fire, and the train held a frantic crowd who slapped out the flames, destroying their own and their neighbors' garments. People by the wayside supposed that the train was carrying a load of maniacs. Consternation reigned supreme, and many people thought of jumping before the engineer perceived the condition of affairs. By that time they were near a water tank where a stop was made, and the burning garments were drenched with water. Many of the pleasure seekers had painful reasons to remember their first ride on a railroad train."

Many thanks to Jim Miller of the Wisconsin Department of Natural Resources for finding that pithy account and letting me use it here. As you may have noted, the story does not mention whether or not there were right-of-way or bridge fires. Then, as now, fires that involve the public get the headlines.

Scope

Just what is fire safety in the B&B part of the railroad environment? Many different types of fires make up the railroad fire problem. B&B people are involved in, or are affected by virtually all of them. Train-caused fires burn ties, grass, poles and fences usually repaired by other railroad groups. But they also burn bridges and buildings—your stuff. Vandals and trespassers burn bridges and buildings with some regularity; this is about the largest source of identifiable fire loss nationally. They also steal your extinguishers, cut your fire hoses, and turn on your fire hydrants.

Rail welders and rail grinders have been known to set fire to things B&B have to fix. Your own activities—facility construction and maintenance projects—can and have caused expensive fires. Fueling activities—locomotive and caboose as well as vehicles and work equipment—have the potential for spectacular fires. Even with the routine, accidental fire, the one with no suspicious quality, B&B is likely to be the group involved in the repairs.

Fires damage property, of course, that of the railroad as well as that of our neighbors. However, fires also injure people, employees as well as outsiders. Property can be repaired or replaced in some fashion. People injured or killed in a fire are not so easily dealt with. Fires also cost jobs. The fire-damaged shop or office frequently is not rebuilt.

You generally have maintenance responsibility for buildings and processes on the railroad, at least those your company operates. This broadly includes: fire prevention, including maintenance of electrical and HVAC systems to avoid fires; installation and maintenance of the normal complement of fire extinguishers; hoses; standpipes; and the installation and maintenance of specialized fire systems, alarms, detection, sprinkler, foam, and Halon, to name several that are now rather common. You folks also get involved in the installation and maintenance of water supply and hydrant systems.

You probably have local fire marshals demanding improvements to your fire protection capabilities. Insurance companies also make demands that affect you. On the other side, other departments of your companies and managements within and without your department can and do have interests that can conflict with good fire safety. For example, a manager attempting to spare his own budget can, as an unintended consequence, cost the company large fire damage claims, claims far in excess of any intended savings. It is most important that you obtain management support for fire safety. Fire safety will not happen without it. Fire safety, as you can see, has a very broad scope.

Fire Prevention

Preventing fires is the first priority whether in railroading, in your home, or anywhere. The fire that does not occur is the one that causes no losses, injures no people, and disrupts no schedules. Here are a few proven techniques that help to prevent fires. These are pretty basic, so I'll go over them quickly. They are all important; however, don't let the fact that they are familiar breed contempt for them.

Housekeeping—Keep trash contained and regularly removed. Handle flammable and combustible liquids with care. Minimize the quantities on hand, keep containers closed. Use UL-approved safety cans for gasoline, alcohol, and other flammable liquids. Use approved flammable liquids cabinets when quantities of flammable paints, solvents, and lubricants must be stored. When welding or cutting, clear the area of combustible first. Have fire extinguishers at standby. Have a designated fire watcher, and make certain he/she stays around for a half hour after the torches are shut off. Use spark shields on machines that cause sparks. Keep vegetation away from tracks, bridges, fuel tanks, and buildings. Do electrical repairs per code. Don't patch electrical cords; don't hang cords on nails, pass them through walls or under carpets. Follow the code on building repairs and remodeling. Maintain fire ratings built into walls and floors—fill those holes. Maintain proper clearances around heat-producing devices. I am sure each of you can come up with many more. As I said, these are basic fire prevention steps—and effective ones. When basics are ignored, the consequences are serious.

We have just talked about fire prevention. As good as prevention is, it is unrealistic to assume that we can totally prevent fires. Some will occur despite our best efforts. So, let's talk a bit about systems and devices that provide some form of fire detection, alarm, and/or suppression. We are talking now about fire protection.

Fire Protection

The original fire detection system, and still the most common and probably the best, is the standard model human being. A person smells, sees, or hears a fire, often in its earliest stages, and shouts the alarm. People give you more than just detection and alarm, however. They usually will extinguish or at least contain the fire if provided with some form of equipment to do it with.

People, however, cannot be everywhere all the time. Recognizing this, and utilizing technologies developed over the past few years, commercial fire detection and suppression systems have been developed and refined to be very effective.

Fire detection systems sense fire usually by measuring heat or products of the combustion process. They range from the simple battery-operated smoke detector in your house, now widely available for as little as $5, to the commercial models that are suitable for interconnection into systems. Detectors themselves come in several forms, and should be selected to provide the closest match between the abilities of that detector and the characteristics of the facility to be protected. Special detection wires, tubes, and similar items are being used to detect fires on bridges.

Alarm systems can be simple or complex. The simplest may have a manual pull that sounds a horn. Add a detector or two and you have a simple, useful automatic alarm system. Or, at the other extreme, there are computerized fire management systems, made up of hundreds of detectors, sprinklers, or whatever, that will cause whole sequences of emergency responses to automatically start whenever a fire is detected. These systems can automatically broadcast several different emergency messages simultaneously, each to the right location for that particular fire. They can shut down air handling equipment, close fire doors, turn lights on or off. If you want them to, they will call the fire department. Similarly, it is quite practical today to have remote readout of fire detection systems. An alarm from a bridge in your hometown can easily be made to read out here in Chicago, perhaps even on the beeper in your pocket.

Fire sprinklers are, without a doubt, the most valuable single fire system known. They actually perform several functions. They are fire detectors, they are an alarm system, and they are an automatic fire suppression system. Sprinklers have an enviable 96 percent reliability record. Records kept for many years prove that the overwhelming majority of fires that occur in properly sprinklered facilities are extinguished with four or fewer sprinkler heads. There has never been a multiple loss of life, outside of the immediate area of fire origin, in any building with a properly functioning automatic sprinkler system. Sprinkler systems are good, and I recommend them highly.

Other fire suppression systems that have railroad application include: Halon 1301, used extensively in crucial facilities such as computer rooms, communications equipment rooms, and dispatching centers where conventional extinguishing agents would be too slow or would cause unacceptable damage. Halon is a gas of the freon family and comes in two variations most suitable for fire protection use, Halon 1301 and Halon 1211. Halon 1301 is best suited for the total flooding system usually found in computer rooms. Halon 1211 works best in fire extinguishers. The halons work at low five to ten percent concentrations and chemically interfere with the combustion process. Properly used, they pose no danger to people.

Halon systems are, by definition, custom engineered for each facility. Halon systems are very good but are also very expensive, both to install and to keep, and have some significant limitations. They require regular, costly service and maintenance, usually by maintenance contract with a specialty firm. The halons are, incidentally, along with chlorofluorocarbons, being accused of depleting the ozone layer. We do not yet know the full impact of that on the fire protection use of halons. However, they are so good at fire protection that I am sure they will be with us for a long time.

Another system is carbon dioxide, now largely replaced by halon, although still appropriate for protecting many clean environments.

Another is dry chemical suitable for many applications but now largely used to protect cooking and exhaust facilities in restaurant kitchens.

Fire extinguishers and fire hoses are still the most common fire extinguishing equipment. They are everywhere, and well they should be. They are necessary to supplement the fancy systems. You do not want to discharge a halon system for a wastebasket fire, as well as for the majority of real world situations where automatic fire suppression systems are not provided. For you, fire extinguishers should be the first line of defense against fire loss.

I strongly suspect that fire hoses will become less and less valuable for you as time goes on. In shops and offices, people are reluctant to use them. Outside, hoses are not apt to be nearby. A charged fire hose can injure someone if improperly handled. And, only one and one-half inch fire hoses with shutoff type nozzles should be provided for any emergency use. Leave the two and one-half inch hoses to the fire department. Fire hoses require regular maintenance and testing, an awkward and time-consuming process when compared to fire extinguisher maintenance procedures.

Fire hoses will remain a superior standby tool for those situations involving predictable fires—those caused by maintenance activities and in such places as car shops where welding is a regular thing. But, for the majority of your situations requiring basic fire protection, I recommend that each of you emphasize the proper selection, placement, and maintenance of fire extinguishers.

Fire extinguishers are readily available. They come in a variety of sizes, shapes, and types, ranging from miniatures containing less than a pound of extinguishing agent—toys, really—to 350 pound wheeled monsters. Extinguishers you should consider contain two and a half to 20 pounds of one of several extinguishing agents. Dry chemical, whether multi-purpose or ordinary, is the most useful and versatile and should be the mainstay of your fire equipment inventory. Others you should use for specific purposes are Halon 1211, CO_2, Purple K, foam, and even, water. The common, standard-duty extinguishers, the ones with a pressure gauge, are always under pressure and require service by outsiders. In the heavy-duty cartridge-operated extinguishers, long a mainstay on my railroad and, I suspect, yours, because of its durability, the agent is not under pressure until time of use. This extinguisher is unique among dry chemical models in that it can be recharged anywhere without special equipment.

In the field environment, water pump tanks and backpack extinguishers are great. Water is still the best extinguishing agent for wood, grass, paper, and other Class A materials, and these extinguishers contain two and a half to five gallons of water. What makes them uniquely suited to field work is that they can be filled from a hose or dunked into a creek, used, refilled, and used again as long as the operator holds up. B&B people working on bridges, crossings, or other rural projects should have several of these on hand.

Fire Equipment Maintenance Requirements

Now come the unpleasantries. All of this equipment, from the exotic like the Halon systems to the mundane like the ordinary fire extinguisher, requires maintenance, the fifth topic. An emergency system or device that is not properly maintained is more dangerous than having none at all. I repeat: an emergency system or device that is not properly maintained is more dangerous than having none at all. These are not ordinary tools that can be readily replaced when they fail, with but minor inconvenience, and perhaps the opportunity to grab an extra cup of coffee in the process, enroute to the tool room. These devices are expected to stand by for years, then in an instant, spring into full operation when fire strikes. There is never a guarantee that they will work in the next emergency. Only the assurance that comes from proper, regular maintenance.

Maintenance covers many different activities. There is the monthly quick check inspection of fire extinguishers and hoses. The purpose of this is to verify that they are there and not obviously damaged or discharged. There is semi-annual maintenance of equipment and systems whether Halon, sprinklers, or underground water and hydrant systems, that requires a thorough going over of a particular device by qualified people following proven procedures and tested parts and pieces. There is annual maintenance of fire extinguishers. Maintenance also includes periodic special requirements—hydrostatic tests, six-year tests, vacuuming smoke detectors, weighing Halon cylinders, as examples—all required for good reasons to assure that the particular device or system will work at the moment it is needed after perhaps years of just sitting there.

Time does not permit going into detail on inspection and maintenance procedures for the many situations involved. In a minute, I will mention a few sources full of information. However, I do wish to impress on you three points concerning fire equipment maintenance: one, it must be done by qualified, trained people; two, it must be done in strict accordance with applicable schedules; and, three, any repairs or repair parts must be approved by Underwriters Laboratories for that device.

A suggestion at this point: fire equipment maintenance has become complicated. The rules affecting fire equipment and systems have become more detailed, and enforcement of these rules has become significantly more strict. The "litigation explosion"—everyone suing everyone for everything—is well known. The day may well be past where people like us can and should maintain our own fire equipment. I recommend more and more retaining qualified licensed firms on an ongoing basis to maintain all fire protection equipment—the complex system, the ordinary extinguisher, the water and hydrant network. If you still choose to do this work with your own people, you had better make certain they are well trained and follow all of the required procedures.

Help and Guidance

At this point, I expect many of you are a little green around the edges. I hope that my comments so far have made you aware of the scope and complexity of the fire safety issue. I intended to do just that. I also recognize that you just might forget a detail or two of what I have said here. And, I have actually given you very few details of the fire safety question.

Help on all aspects of fire safety is readily available. Take advantage of the wealth of assistance and guidance that is out there. This is the sixth and last part of my presentation. The single best source of guidance, be it books, codes, standards, videotapes, or seminars is the National Fire Protection Association. The NFPA, for those of you not fully familiar with it, is a non-profit membership organization based in Quincy, Massachusetts, a suburb of Boston, dedicated to promoting safety from fire, electricity, and related hazards through research, codes and standards, technical advisory services, and public education since 1896. This is **the** source, worldwide.

Get their catalog—it's free, of course. I have a copy here you can look at. Order an interesting-sounding book, tape, or video. Their Fire Protection Handbook, now in its 16th edition, is an excellent first reference for anyone with a fire safety question. Their 12-volume set of National Fire Codes contains perhaps 260 separate, regularly updated, codes and standards. These are the foundations for practically all of the fire and life safety portions of local building codes as well as the OSHA standards. They include, incidentally, the Life Safety Code (NFPA 101) and the National Electrical Code (NFPA 70), as well as many others you may have heard of.

Local building codes and local building and fire officials are good sources of information on fire safety, both for a specific project as well as for general guidance. They will tell you what fire safety features are required on your project. Most local codes are based on NFPA where fire safety is involved, but not all will copy NFPA exactly. The differences between the codes can cause trouble if not discovered in time.

In the rural environment, local, State, and Federal foresters can be very helpful.

The NFPA Railroad Section is also a good resource. As I mentioned earlier, this is the professional association for railroad fire protection specialists. Feel free to contact us individually, or as a group, in care of the National Fire Protection Association. We will know right away what you are talking about. NFPA staff members are another excellent source of information, particularly for interpretations of codes and for technical advice. Call them directly if you wish, or let us, the Railroad Section, make the contacts for you.

Vendors are also excellent resources. Many of them will provide detailed technical help. They are, of course, trying to sell you their product, and you must exercise a little caution because of this, but most vendors will provide you with a valuable service.

For large or complicated fire protection projects, for the situation with extremely high potential losses, or merely the situation where you do not have the time or expertise to design the fire protection, consider using a fire protection consultant. There are a number of firms specializing in fire protection consulting. Hire one, and they will do it all including, if you wish, reviewing the bids and overseeing construction and acceptance testing. Consultants do cost money. However, the overall project cost often will not increase, because the consultant will have designed a state-of-the-art fire system that is more efficient, yet less expensive, than you would have received without his services.

I am not here to name names, whether consultants or products. However, the Chicago area is home to two of the country's most respected fire protection consulting firms.

In summary, fire safety is not a simple chore. Fire safety is the result of a complex series of events, some within our direct control, some not. Fires have been a part of railroading since railroading's very beginning. B&B people are involved in every aspect of the railroad fire situation.

I have talked about the many components of fire protection hardware: systems for detection and alarm; systems for fire suppression; Halon, sprinkler, and others; fire equipment, primarily fire extinguishers. I have stressed the importance of fire equipment maintenance: it is mandatory. Without proper maintenance you do not have emergency equipment, just hardware of doubtful reliability. Lastly, we discussed sources of assistance, where you can get the help and guidance you need. It is my hope that you find this information helpful. This concludes my portion of your program this morning and I appreciate your kind attention. (Applause)

President Lewis: Thank you, Mr. Fitch. If there are no questions, this session is adjourned until 1:15 this afternoon and we will meet back here in the State Ballroom.

Adjourn

TUESDAY AFTERNOON SESSION

September 20, 1988

President Lewis: Welcome to the continuance of the second session of this conference. Will everyone please be seated. The attendance as of noon today is 135 B&B; 178 Roadmasters; 103 Guests; 204 Associates; 64 Ladies, for a total of 684. This is a very good showing for Chicago, and I thank you.

At this time, I would like to call on Bill Nelson, sponsor of Special Subject No. 4, to introduce our first report of the afternoon session. Bill.

Mr. Nelson: Thank you, Don. I am very pleased to have the opportunity to sponsor this Special Subject No. 4 called "Repair and Maintenance of Counterweight Systems". As chairman of this committee we have with us today a young and energetic engineer who is responsible for the bridge repairs and maintenance on one of the Class I railroads. This young man is a graduate of the University of Nebraska, and he asked that I point out those with affiliations to Texas A&M or Utah State are very welcome to stay. (Laughter) However, those with ties to UCLA or Oklahoma, and then there was a little pause, when he told me this, he said, "Well, just tell them they can see the exit lights". (Laughter) But really, you are all welcome to stay.

I present to you Joe Lileikis, manager of bridge maintenance, Union Pacific Railroad.

SPECIAL SUBJECT NO. 4

Repair and Maintenance of Counterweight Systems

Chairman: J. A. Lileikis, Sys.Mgr.Br.Mtce., UP, Omaha NE

Committee: B. T. Burns, Asst.Mgr.Strs., AT&SF, Topeka KS
H. L. Davidson, Engr.B&B, CSX, Corbin KY
P. F. Viehweg, Sr.Proj.Engr., EJ&E, Joliet IL
J. W. Hartmann, Strl.Dsgnr., Howard Needles, Tammmen & Bergendoff, Kansas City MO
D. F. Sorgenfrei, Assoc., Modjeski & Masters, New Orleans LA
M. Parnell, Pres., Wire Rope & Rigging, Vancouver WA

Anyone who has ever had to stand up in front of a large group or organization and intelligently present a topic of discussion knows that it is virtually impossible to do so single-handedly. I hope you will find this presentation to be both informative and entertaining. I would like to take this opportunity to thank the rest of the committee that helped me put this presentation together.

During the past few months I have been canvassing as many railroads within the North American continent as possible in an attempt to determine roughly just how many railroad bridges are in existence that are dependent upon a counterweight system for movement of some sort. Having written letters to over 150 different types of railroad lines, disturbing the cherished hallows of many a chief engineer's office in the process, I have, to date, been informed of roughly 85 lift span bridges and 40 bascule type bridges. One of the astonishing items I have discovered during this search was that each and every one of these bridges is over a body of water! Imagine that.

Since many of my roadmaster friends have been painstakingly trying to familiarize me with what track is, in the event that some of them are scattered among us today, I should probably begin by indicating that this is a bridge. And it normally has to look like this before a train should be allowed to cross it.

Bridge Types

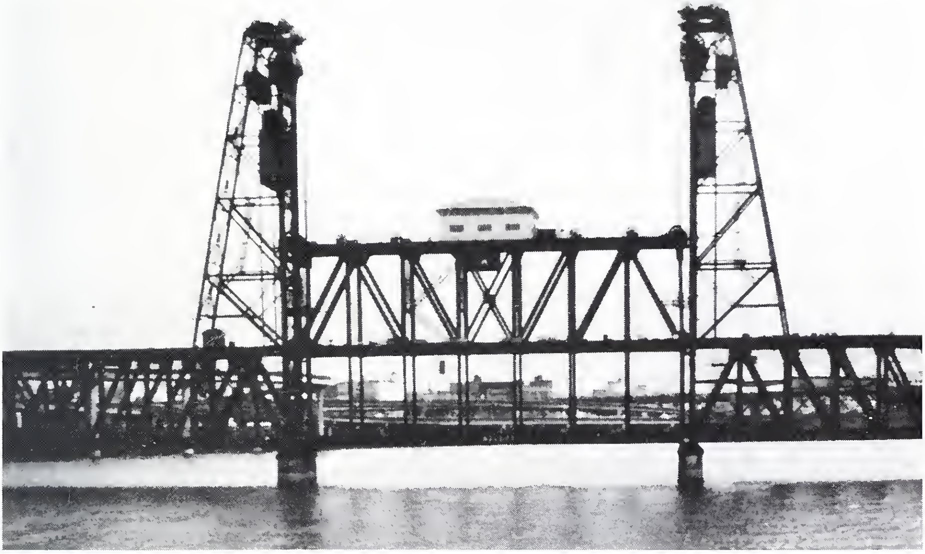
This slide, along with the preceding one, shows a Strauss trunnion bascule lift bridge, one of three basic types of bascule bridges. Bascule bridges are those that open by rotating a leaf, or leaves, from a normal horizontal position to a point that is nearly vertical. As mentioned earlier, there are three basic types. The heal-trunnion (or Strauss) as shown here, the rolling lift, and the trunnion bascule.

The vertical lift bridge, my personal favorite, also relies on a counterweight system for movement. The counterweights, while supported by lifting cables, are put into motion passing through the steel framework of the towers, and eventually raise the main span, while still horizontal, in a vertical fashion.

Counterweights, therefore, are used to balance movable bridges reducing the overall requirements for machinery to lift a span. With the use of counterweights, the machinery requirement is only to overcome friction in the bearings, put the bridge in motion, and power any imbalance specified.

Generally, the counterweight system for a vertical lift bridge consists of a guided counterweight in each tower roughly equal to one-half the weight of the lift span. The counterweight is connected to the lift span with wire ropes that travel over sheaves.

A rolling bascule bridge has a segmental girder as part of the span which rolls on a track girder. The counterweight tilts about 90 degrees as the span is rolled. The counterweight on a Strauss bascule is connected to the lift span through a parallelogram of links, pivots around



Lift span.

a tower support, and tucks under the support when the span is fully raised.

There are other types of counterweight-dependent moveable bridges such as a bobtail swing and others, but I cannot even begin to tell you what the heck they look like, let along how they work.

Bridge Inspections

Successful maintenance and repairs to either type of structure is primarily dependent upon an adequate and thorough inspection, outlining potential problem areas, and nipping small problems in the bud before they become major catastrophes. One of the most critical aspects of a quality inspection is to have an able bodied assistant. (Laughter) Once this is obtained, the rest of the inspection is relatively a piece of cake.

An entire 45-minute dissertation can be presented on the inspection needs and requirements of any of the bridges just shown, especially for the unique structure shown in the previous slide.

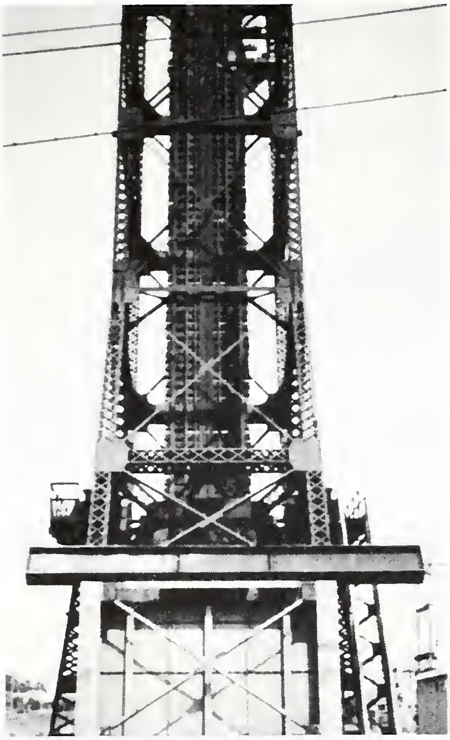
The obvious reason for inspecting a bridge is to observe and note any deficiencies that require immediate corrective measures, while allowing for the scheduling of any needed long-range repairs or maintenance. The impact of an inspection, however, is lessened if deficiencies are detected and corrective measures taken, but the cause of these problems is left unsolved.

Although I will highlight some of the critical areas that require a comprehensive inspection, I strongly suggest that a document entitled ''Bridge Inspector's Manual for Movable Bridges'', published by the United States Department of Transportation, be obtained and reviewed by those who perform inspections of this nature.

Many components comprise counterweight dependent movable span bridges, and all must be functioning properly if the bridge is to do what it was designed to do—move.

The pivoting portion of a bascule bridge known as trunnion shafts is located on a common center line and mounted in bearings that are attached to the pier. These must be in alignment, or the leaf will not operate properly. Inspection of bolts, hubs, rings, and fasteners for noticeable cracks or defects is necessary to ensure that the trunnion housing is intact. Any unusual noise coming from the shaft assembly during lifting operations is normally a clue that a misalignment of the trunnion shafts is possible.

The curved and straight tracks of a rolling lift bascule bridge should be inspected during operation to confirm complete contact between the two surfaces as they roll together. Lugs and



Bascule span counterweight.

pockets should be inspected for wear, and, if any noticeable contact between the sides of these lugs and pockets exists during movement, it is evident that misalignment exists somewhere in the span. Inspecting the gear teeth of the mechanical componentry for unsymmetrical wear can also lead to a determination of span imbalance.

Machinery for vertical lift bridges is usually somewhat more elaborate and complicated than that for bascule bridges, but the major points of inspection are virtually the same.

In the inspection of vertical lift bridges, there are indications to watch for that will tell that the bridge is not properly balanced. The lift span travelling faster in one direction than the other, requiring the application of brakes to retard lowering, or the lack of need for power to raise the span, is a dead giveaway of an unbalanced span. If the span tends to float and does not properly seat, a problem greater than just imbalance could exist. This usually requires a 2:00 a.m. vigil by the B&B supervisor, working with an irate signal maintainer, followed by a 6:00 a.m. call to the chief engineer explaining why Amtrak was held up for three hours. From experience, I can tell you neither is very enjoyable. But I will give you a clue that your problem might exist within the equalizer assembly at the counterweight hanger connection.

Wire rope inspection is also essential for vertical lift bridges. This is not a good wire rope and should probably be replaced. A wire rope is comprised of strands which are made up of wires. The number of wires per strand varies as does the number of strands per wire rope. Strands are normally wrapped around an inner core which is usually either made up of wire or fiber like a hemp rope. Inspection of the rope's core is possible but should not be attempted by an inexperienced individual due to the potential for nicking, gouging, or deforming the core or strand wires.

Contact points with sheaves and connections to sockets are primarily the main points of inspection for wire rope wear or damage. At the tangent points to the sheaves, the wires are susceptible to wind or vibratory fatigue and abrasion. The rope's diameter should be measured and its location recorded on the appropriate form for future reference.

Alignment of ropes from sheave to sheave should also be reviewed. The element of concern is having the proper alignment to avoid unnecessary abrasion. Improper alignment can be initially detected by a shiny, unlubricated sheave on the scrubbing side, with metal loss evident on both the sheave and the wire rope.

Broken wires usually occur as a result of one of three things. Bending fatigue (which for railroad bridges is usually age and bending cycle dependent), cutting, gouging, and abrasion, and from separated butt welded wire ends.

According to ANSI and OSHA standards, the criteria for replacement or removal from service of wire rope based on the number of broken wires is two or more broken wires at the socket ends, and in the body of operating ropes, six broken wires in one length of lay, or three broken wires in one strand in one lay length. A lay length is defined as the distance it takes for one strand to make a complete spiral around the rope's core.

One of the first aspects of sheave inspection is the condition of the grooves. To check the size, contour, and amount of wear, a groove gauge is used. Figure A depicts a well-grooved sheave; Figure B a worn sheave and Figure C a sheave groove too large for the size of the wire rope intended for use.

Regardless of bridge type, an adequate and thorough inspection can only be obtained by interviewing bridge operators, maintenance personnel, and others who deal with the structure on a first hand, day-to-day basis. This, combined with the review of previous inspection reports and original design drawings, along with a systematic and logical approach to the inspection itself, could insure that all key areas are overviewed, and any components where failure or breakdown is imminent are reported and corrective measures taken.

Repair-Replacement

The repair or replacement of the mechanical componentry of any movable bridge could be as simple as replacing the braking system for a vertical lift bridge or as complex as the major replacement of a gear or a sheave. This highly sophisticated braking system recently underwent a major rehabilitation. New oak blocks are shown being installed on the steel strap that wraps around the braking drum and, once installed, requires to be seated.

The tower bearings and trunnion shafts of this bridge were grooved and worn, creating drag during operation, thus causing constant mechanical problems. The solution was to replace eight tower bearings and turn the trunnion shaft to a smooth operating condition. This is a relatively simple operation if done in a machine shop but not so simple from a river barge work site and atop the tower platform.

The first step of this major overhaul was to build new bronze bushings, shown here already in place and being protected from contamination by flying insects with a readily available can of Raid. All new bushings were cast and machined to within one-eighth inch less inside diameter than existing shafts, allowing for the turning down of these shafts, thereby eliminating the problem grooves.

Since raising the bridge is extremely difficult with the mechanical componentry dismantled, the stoppage of river traffic was imperative, which usually means the loss of your first born to the local commander of the coast guard.

With four 200 ton hydraulic jacks in place underneath it, the counterweight was raised approximately six inches to release the pressure caused by 40 one and seven-eighths inch diameter wire ropes. Atop the tower, and under the sheaves, four 30 ton hydraulic jacks were placed in order to raise the sheaves and cables an additional one inch. This allows for the removal of bearing blocks, which were hauled to the work barge for cleaning, and the installation of the new bronze bushings. A portable lathe was attached to the trunnion shaft and the chore of turning down the shafts now began. Approximately eight hours later, one shaft had been turned.

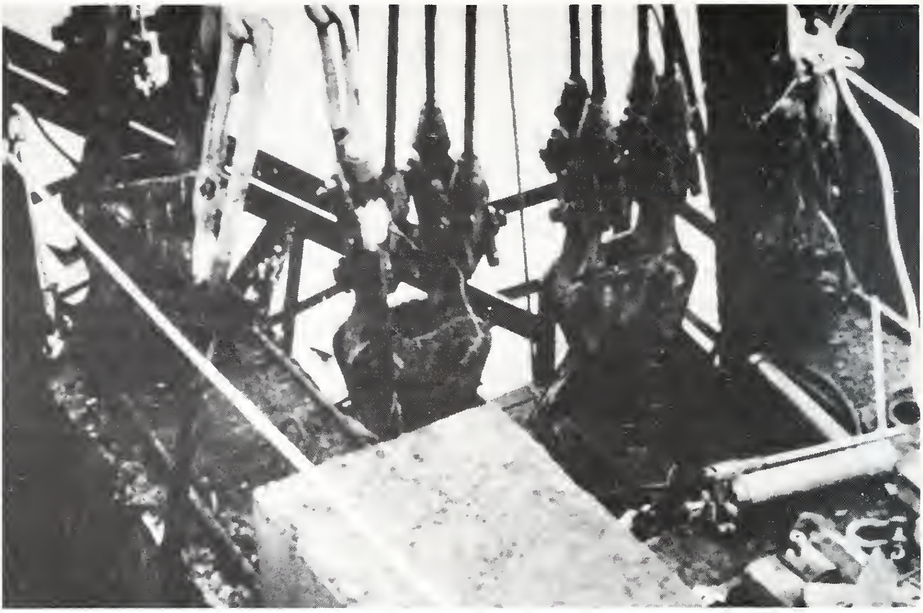
Putting back the pieces was the next task at hand. I have always contended that if given the same type of machine or piece of equipment to dismantle and put back together, after three tries I will have almost enough parts left over to build a new piece of equipment that resembles the one I have been dismantling. Fortunately, the people who did this job were real pro's, and made all the pieces fit just as had been intended. The newly turned trunnion was seated in the freshly cleaned bearing block with new bushings, lubricated, and closed up.

Jacks were then removed from underneath the sheave and then the counterweight and 48 hours after the operation commenced, the bridge was put back into service with one of the two towers completed. Incidentally, the second tower was completed approximately one week later, with no appreciable difference in the amount of time taken to complete the job.

As it is becoming apparent, the replacement of any major component of a movable bridge is not an easy project and has a tendency to single-handedly shoot the lights out of a bridge budget.

Unfortunately, lift span cable replacement does not differ in this respect either. As mentioned earlier, bending fatigue for wire rope on most railroad bridges is a result of the age and number of bending cycles. Obviously it is cost prohibitive to randomly replace the cables of a lift span just because they are 20 years old if no apparent signs of abrasion, broken wires, reduction of cable diameter or damaged end fittings are present unless, of course, you can find some governmental agency to foot the bill for new cable.

In the event cable replacement is unavoidable, a considerable amount of time, energy and deep soul searching are required just to put together



Counterweight equalizers.

enough information that gives you, and only you as it turns out in the end, the feeling that you are now a bonafide wire rope expert and nothing can, nor will, go wrong with your replacement project. All the calculations in the world from all angles and all the additional information you have obtained from national wire rope experts sometimes just cannot prevent some poor guy like this from trying to stretch that one and one-half inch diameter cable that last couple of inches.

I have learned that the real reason cables on lift span bridges are not replaced very often is that anyone who has replaced them once is reluctant to do so a second time. Well, I thought that after my first rope replacement project, I was ready to set the world on fire with a surefire, no-way-I-could-go-wrong method. Guess what?

Of utmost importance, however, in any cable replacement project, is that the fabrication of the new lifting cables is done so as to complement the method of installation. It does not do a lick of good to stretch the tar out of the cables to a certain tension if you are not going to install the cables at the same tension that they were fabricated, measured, and cut. Think about it. How can you safely, and I emphasize safely, install a cable with a tensile capacity of 125,000 pounds, that was pre-stretched to only 12 percent of its capacity, 15,000 pounds, measured while under load, marked, cut and socketed, and allowed to recoil however much it wants to recoil. Remember that in order for you to obtain the needed length, you have to pull it into place with 15,000 pounds tension, and somehow connect it to either the counterweight or the lift span—virtually impossible if all workers' limbs are to remain intact.

Proper fabrication, however, is essential. A wire rope stretched to 40 percent of its ultimate capacity, held, released, and re-stretched an additional two times will eliminate much of the rope's constructional stretch, provided that after fabrication these ropes are placed on shipping spools of large diameter, and installed within minutes of being received at the job site. Actually, pre-stretching cables is an advantageous way to eliminate the initial stretch that occurs within the first few years, but it is imperative that the initial amount of recoil after prestretching be known and compensated for prior to installation.

The tensile testing of wire rope samples is an extremely important as well as a closely followed procedure for testing the quality of the socketing process. This testing allows for the determination and verification that the specified ultimate capacity of the wire rope is, at a minimum, met, and no other apparent or inherent problems exist.

Even though it is as rare as a 15 percent raise in pay, wire rope socketing failures do happen. Can you imagine the consequences to the bridge and the public if you had not had the wire rope assembly proof tested and this happened? Incidentally, the wire rope manufacturing industry has been working for the past number of years perfecting the process of socketing wire rope with an epoxy resin instead of the more traditional pure zinc.

Raising Counterweights

The installation procedure for new operating ropes should be one which complements the pre-stretched wire rope and does not disturb or damage the rope's body or end fittings. The method used for raising the counterweight to a specified height, and supporting it in place during cable replacement, is as essential a design requirement as selecting the proper strength cable.

Should the counterweights be small enough, a sling can be placed around the counterweight and lifted by use of hydraulic jacks from above. It is advisable, however, that if this method is used, you get the biggest, burliest, monster of an individual on the counterweight just in case something slips.

Larger counterweights require quite a bit more ingenuity in order to raise and usually a great deal more money in your budget. Devising a system of structural steel jacking members spanning between tower legs and raising the counterweight from the underside with large capacity hydraulic jacks proved to be an effective method in this cable replacement project. As the counterweight was raised, steel grillages were placed under the weight allowing for additional jacking until the final height for cable replacement was obtained. Note that during the jacking operation, lead packs were placed between the steel shims and the irregular concrete counterweight underside, allowing for the maximum possible contact surface.

A third possible method of counterweight raising has not yet been fully explored, but "the other guys" are looking into it.

No matter the method of counterweight jacking, attention should also be focused on pin and equalizer plate rehabilitation or replacement. Connecting pins that have been removed have shown considerable grooving takes place over the course of time. Removal of equalizer plates and, at a minimum, just cleaning all rusted surfaces should be a requirement. Replacement with new material, although an added cost, can only enhance the operation of the new lifting cables.

The installation of new cables, once existing cables have been replaced can easily be achieved by pulling the new cable in while pulling the old cables out one at a time.

Cable Fabrication and Installation

During cable fabrication, the cables will more than likely be paint striped, indicating the lay of the cable in what will be its relaxed state. Care should be taken during installation, therefore, to place the new cables so that the paint stripe is as directional after installation as it was during fabrication.

Once installed, and counterweights are set down, the final step of cable replacement work is now necessary—greasing the cables. Automated greasing devices are available to perform this task but some prefer to do it the old fashioned manual way.

Counterweight Repairs

Counterweight deterioration depicted here by the evidence of spalled concrete and exposed reinforcing steel, or a rusted through steel encasement, can be a severe detriment to the uniform movement and operation of both a bascule and a lift span bridge.

As with many bridge related problems, the repair type selected for counterweight restoration is very dependent upon the severity of damage or decay, allowable time frame for subsequent repairs, and most importantly, budget constraints. Counterweight repairs, therefore, can range from the most simplistic and obvious approach to those that reflect the most elaborate methods available.

The rusted through steel encasement shown earlier was easily and economically repaired by the addition of steel angles across the rusted out areas, thereby re-establishing the integrity of the counterweight.

Field experience occasionally dictates the repair method selected. In this instance, an approximately seven foot long crack in line with the interface between the concrete counterweight and the steel support was detected during an inspection, and, with the operation of the span, the crack was noticed to open and close. With the span in the open position, therefore keeping the crack closed, the damaged zone was cut out with an air-arc, and repaired by welding with pre-heat, interpass, and post-heat processes. Another simplistic, obvious, and extremely effective repair.

Occasionally, simplistic and temporary repairs are followed up years later with those that are more intense. This concrete counterweight had previously undergone patchwork attempts, but the deterioration and spalling of concrete had persisted. It was decided, therefore, to encase the concrete counterweight with a steel skin. As with many railroad related projects, observation and project inspection play important roles in the completion of tasks. Here supervisors shed their ''white hats'' in order to blend better with the work force. Once the supervisory personnel had left the job site, the task of placing the supporting steel had begun. In order that original design clearances were not infringed upon, certain areas of the concrete counterweight had to be chipped away allowing for the placement of the steel framework and plate support members around the counterweight. Certain areas required for the physical attachment of the plate work to the concrete counterweight. Framework intact, the steel plate skin was added, and the concrete counterweight was now encased. Again, a more elaborate fix, but also extremely effective.

Although not covered in great detail within this report, it should be noted that deteriorated concrete counterweights have undergone restoration using a wet mix shotcrete process. Crumbling concrete, in one instance, was chipped away at a rate of three to four cubic yards per repair cycle, therefore not impeding the operation of the movable span. After sandblasting exposed steel and adding additional reinforcing steel as required, shotcrete was applied in several layers, ensuring that enough passes were made to leave the surface about one-half inch high. Finishers then cut the material to the desired grade.

The replacement, however, of counterweights is not a common occurrence. The decayed counterweights shown here are scheduled for replacement with precast concrete counterweights. Unfortunately, this project has not yet advanced to a stage where discussion of this topic is practical.

Whether engaged in the repair, replacement, or simply just the constant maintenance of counterweight systems for movable bridges, I cannot stress strongly enough the importance of a good working knowledge of the type of bridge encountered. It is essential to be cognizant of how all aspects of a movable bridge work with respect to one another. An adequate understanding in this regard will allow for thorough inspections to take place, recognize potential areas of detriment and failure, and establish the most economical and advantageous repair scenario. Thank you.

(Applause)

President Lewis: Thank you, Joe. Are there any questions of Joe? I would now like to call upon Mr. John Kapp, our immediate past president, to introduce all the past presidents who are in attendance today. John.

INTRODUCTION OF PAST PRESIDENTS

Mr. Kapp: Thank you, Don. Past Presidents with us today are J. R. (Jack) Williams, vice president with Alfred Benesch Company, president 1975-1976; J. R. (Jerry) Iwinski, assistant chief engineer structures, Chicago and North Western Transportation Company, president 1977-1978; W. C. (Wally) Sturm, senior project engineer, Elgin, Joliet and Eastern Railway, president 1978-1979; J. (Jim) Budzileni, retired senior structural designer with Illinois Central Gulf Railroad, president 1983-1984; J. M. (Jim) Williams, retired supervisor B&B, Elgin, Joliet and Eastern Railway, president 1984-1985; and, D. A. (Don) Bessey, senior architect, Envirodyne Engineers, president 1985-1986. Thank you, gentlemen. It is a pleasure to see you all. (Applause)

President Lewis: Thank you, John. On behalf of the Association I thank all of you past presidents. By tomorrow I will be one of you and I can't think of a better group. Right? (Laughter) I personally would like to thank you all for your continued interest in the Bridge and Building Association and I know it has been your "Get Involved" feelings also that keep you active.

Now, Mr. Kapp, as past president and chairman of the Nominating Committee, will you please present the slate of candidates recommended by the committee for consideration as officers. John.

Mr. Kapp: As immediate past president one of the real pleasures you get in working with the Assocation is seeing a lot of the people you have worked with in the past years grow up, become more responsible and take on different responsibilities through the years. I have worked with almost all of the people who are going to be nominated today and I feel they are a very good and a very honorable group.

NOMINATING COMMITTEE

The nominees are as follows: For President, Raymond A. Tallent, Jr., process engineer structures, Norfolk Southern Corporation, Atlanta, Georgia; Senior Vice President, Byron T. Burns, assistant manager structures, Atchison, Topeka and Santa Fe Railway, Topeka, Kansas; Junior Vice President John J. Horney, program engineer B&B, Union Pacific Railroad, Omaha, Nebraska; Junior Vice President Mark C. Walbrun, manager of engineering, Amtrak, Chicago, Illinois. For the new Directors: Steve Lipkus, bridge and structural maintenance engineer, Canadian National Railways, Edmonton, Alberta, Canada; Michael L. Bradley, project engineer, Conrail, Columbus, Ohio; Thomas V. Dunn, bridge engineer, Chicago and North Western, Chicago, Illinois. Don.

President Lewis: Thank you, John. You have heard the slate of nominees recommended by the Nominating Committee. Are there any further nominations from the floor? There being no other nominees, I will accept a motion that the slate submitted by the Nominating Committee be elected. Do I have a motion?

Member: So moved.

President Lewis: Is there a second?

Member: I second.

President Lewis: The motion has been made and seconded that the slate of candidates recommended by the Nominating Committee be elected to the offices specified. All in favor, signify "Aye". Those opposed signify by "Nay". The Ayes have it. I hereby declare these officers duly elected.

Thank you, gentlemen. We will now proceed with our Business Session and provide the necessary reports. If there are any questions concerning any one of the reports, I request that you hold your questions until after the reports have been presented.

Will our efficient and amiable Secretary, Mrs. Pat Weissmann, please give the Secretary's Report. Pat.

MEMBERSHIP REPORT
September 1, 1987 Through August 31, 1988

Total members, September 1, 1987			665
New members since September 1			68
			733
Less: Deceased —	Active	3	
	Associate	1	
	Life	5	
Dropped —	Active	31	
	Associate	7	
	Life	2	49
Total members, August 31, 1988			684

	8/31/88	8/31/87
Active	424	404
Associate	77	79
Life	173	172
Honorary	10	10
	684	665

President Lewis: Thank you, Pat. Will the Treasurer, Mr. Jim Williams, please read the Treasurer's Report?

TREASURER'S REPORT
September 1, 1987 Through August 31, 1988

Checking account balance, September 1, 1987		$ 7,629.06
RECEIPTS		
Dues	$11,160.00	
Advertising — 1986	725.00	
1987	9,125.00	
1987 conference (net)	3,497.00	
Interest on checking account	358.49	
Executive Committee meetings	379.78	
Miscellaneous	420.00	
Transfer of funds	5,000.00	30,665.27
		38,294.33

DISBURSEMENTS

Salaries	$ 8,271.84	
Payroll taxes	688.74	
Office rent, utilities & insurance	1,077.51	
Office supplies	271.07	
Equipment purchase, rent & repair	246.62	
Stationery & printing	1,644.07	
1987 Proceedings	8,842.48	
Membership certificates	238.44	
Postage	1,250.00	
1987 conference expenses	683.23	
1988 conference expenses	138.59	
1991 conference expenses	85.87	
Temporary office help	52.25	
Refund of overpayment of dues	200.00	
Banner	669.80	
Executive committee meetings	1,031.20	
Transfer of funds to savings & loan	4,000.00	
Miscellaneous (incl. fgn.ck.chgs.)	151.48	
Magazine subscriptions	33.06	
1988 advertising	189.13	
Bonds for Secretary & Treasurer	100.00	29,865.38

Checking account balance, August 31, 1988	$ 8,428.95
Homewood Federal S&L Money Market (8/31/88)	6,505.01
Total funds, August 31, 1988	$14,933.96

President Lewis: Thank you, Jim. Jack Williams, of the Auditing Committee will present the Committee's report. Jack.

AUDITING COMMITTEE REPORT

To the Members of the American Railway Bridge and Building Association:

Gentlemen:

The undersigned have examined the books of the Secretary and report of the Treasurer for the period September 1, 1987, through August 31, 1988, and have found them to be correct as of August 31, 1988.

(signed) J. R. Iwinski, Chairman
(signed) J. R. Williams
(signed) W. C. Sturm

President Lewis: Thank you, Jack. I don't know if all of you know how small the office is but when the Auditing Committee has to go in there and audit the books, they have to put up folding tables and if one wants to get up, everyone has to get up. (Laughter) I would like to thank the committee for taking time to go to the Association headquarters to audit the books. Chuck Thompson, chairman of the Necrology Committee, will give the next report. Chuck.

NECROLOGY COMMITTEE

To the President and members of the American Railway Bridge and Building Association:

It is with grief and regret that we report the known loss of ten members through death during the past year. It is possible that other members have passed away during the year of whom we have no information. If you know of anyone, please report their names to the Secretary. The following have been reported since our last Annual Conference in September, 1987:

J. D. Brown, Jr.
Sr.Proj.Engr.
CSX Transp. Co.
Joined 10-9-72; Died 5-1-87

Herbert H. Carver
Supv.B&B
KCT Ry
Joined 8-31-71; Died 5-24-88

Robert C. Crosby
Exec.Consultant
Railway Products Co.
Joined 3-6-61; Died 7-8-88

Charles E. Elliott
Engr.M/W & Strs. (Ret.)
WP RR
Joined 3-13-50; Died 6-29-88

Neil Erikson
Sr.Str.Engr.
Capitol Engineering Corp.
Joined 12-7-79; Died 8-22-88

John R. Hutton
Reg.B&B/Utl.Mgr.(Ret.)
SLSW RR
Joined 9-11-68; Died 2-11-88

Harold R. Julius
B&B Supv.(Ret.)
IC RR
Joined 10-16-63; Died 1-10-88

William C. Oest
Prin.Asst.Engr.(Ret.)
FW&D Ry.
Joined 9-13-47; Died 11-25-87

James W. Seltzer
Sr.Civil Engr.(Ret.)
Penn Central
Joined 2-25-58; Died 11-17-87

Charles B. Williams
President (Ret.)
Ever Tight Bolt Assembly Co.
Joined 9-12-54; Died 3-13-88

I would like to ask for a moment of silence in honor of our deceased members.

Respectfully submitted,
C. E. Thompson
Chairman

President Lewis: Thank you, Chuck. Are there any questions regarding these reports as presented by the Secretary, Treasurer, Auditing Committee and the Necrology Committee? If there are no questions or discussion, I will request a motion that these reports be approved as given.

Member: So moved.

President Lewis: Is there a second?

Member: I second.

President Lewis: The motion has been made and seconded. All in favor signify by saying "Aye". Those opposed "Nay". The Ayes have it and the motion is carried and the reports are approved.

Let's move along to our next presentation, which will be introduced by John Horney, Standing Committee Chairman. John.

Mr. Horney: Thank you, Don. The B&B Association has three standing committees that are ongoing every year. One is on equipment, one is on material and the other is on training. Last year we had a comprehensive report on training, with a brief summary on equipment and material. This year we have a comprehensive report on material and will have a brief summary on training and equipment status, as we have worked on these subjects during this past year.

At this time to give us this in-depth report on material I have great pleasure in introducing Sid Blaauw, who is vice president operations of Paxton Vierling Steel Company in Omaha, Nebraska. Sid is a graduate of the University of Michigan and received his engineering degree in 1973. He is a member of the AISC Committee of Standards and Operations, and a past section chairman of the AWS. It is our intent with Sid's presentation to talk about an in-depth concept of why steel deliveries are sometimes late. Now, in keeping with why steel deliveries are a little bit late we are wondering where Sid Blaauw is. (Laughter) There he is.

STANDING COMMITTEE — MATERIAL

TIMELINESS OF STEEL DELIVERIES

Sid Blaauw

Vice President Operations
Paxton Vierling Steel Company

Mr. Blaauw: Good afternoon. I want to take just a moment to thank John for giving me the opportunity to come and speak to you people about the timeliness of steel delivery, especially taking into consideration, it isn't from an irate contractor asking where his bridge is. I think we have all been down that road on one end of the phone or the other from time to time.

I guess where I'm coming from is my presentation isn't going to be that much in depth, but it may be sharing from a fabricator's standpoint the frustrations that we have dealing with the steel mills, the contractors, and project scheduling in general. I have what I feel is a pretty good overview of the whole project scenario that I would like to show you this afternoon.

Paxton Vierling Steel is an above average sized fabricator located in the Midwest, and our main objective is basically to serve our customer base and to keep our people busy. If our people aren't busy we are not making money, and we are definitely not going to be project schedulers. Steel is the only material that we work with at Paxton-Vierling Steel whether it be fancy tri-chord trusses, or girders, or just your basic beam columns. That is our livelihood. Trying to get steel sometimes and trying to get it out the door is just like trying to deal with our children. It can be a very frustrating scenario.

At Paxton-Vierling Steel we spend an awful lot of time trying to project what our shop load will be, so that we can maintain our integrity delivering good quality steel on time. We go through three different formats, where we routinely do a shop loading, where we will project every job and total number of manhours we have sold trying to give upper management a feel for what our backlog is for our shop. We'll also take this backlog and break it down for schedule and show how many hours we have sold per project per month. This is my basic tool for figuring out how our manpower is, whether or not we are oversold, undersold, or if we have to go to overtime, or how we actually stand. We also break it down just a little bit further, and this comes from past experiences, not only having late steel deliveries coming to us from the raw materials side but detailed drawings and things like that, so we break down into manhours what we have available for the shop, because the drawings have already been released. We break it down where we have drawings that are in for approval at the engineering cycle. We have drawings that are being detailed, the job is up and running. And lastly, we have jobs that have just been sold and are not really started yet. The reason that we go to this particular breakdown is because we can be planning on utilizing manhours for a given month when the drawings haven't even been started yet, and the project could be put on hold, and we are sitting with an idle shop for six weeks or so.

We also go through on a status basis to make sure that we can maintain how a given project is doing. We go ahead and plot what the manpower usage would be and the percent completed. So we can track a project from start to finish. We have spent a lot of time doing this, because a customer who needs just-in-time fabrication is falling just behind just-in-time inventory for our warehouse operation. Because without the material that we need all the projects scheduled, all the projection of shop manloading, and the whole nine yards, does us nothing. You can't unload it if it hasn't been delivered. For bridge work, you can't start ripping flanges, which is a highly labor-intensive item, until the material is there. You can't prep your webs, you can't start welding up your girders, until you have the material.

The biggest problems that we run into is scheduling work for our shop, getting the drawings released, getting people fired up for starting the prep work and having the material start up two to three weeks late. A basic project schedule for most of the work that we do runs somewhere between a 12 to 18 week fab cycle from start to finish. On this particular slide, the top red box indicates basically we have been awarded a project, and we have an initial setup trying to decide in which of our plants we want to perform the fabrication and that usually takes a week to get it distributed. The orange box is basically where we go into material ordering. We do our preliminary, figure out what we need, what lengths we need, and the quantity. To the right of the orange box there are two starts. That is basically when we expect to start receiving the material and when we plan on being complete. In the past, that has usually run between four to six weeks for structural, four to eight weeks for plate work. This is crucial when you are trying to schedule and fill your shop and maintain delivery commitments. Basically when you look at a schedule like this, this is either part of your contract document or something you agreed to at the time of award because, as the contractor, or as the owner, you have downstream contractors that you are going to have to get in place so they can schedule their work also. The green box is detailing, pretty straight forward, especially in bridge work, as well as actual material ordering, and usually runs in a three to four week cycle. The blue box is engineering approval of drawings so that we have something on which to start fabrication. The average turn-around is approximately two weeks. The yellow box is basically our processing time. Just because the drawings have been sent back from an engineer doesn't mean they are ready to go into our shop. It takes us approximately a week to go through, make our cutting list, do our template work, and actually release it for fabrication. At that point fabrication can begin.

This is a pretty straight-forward schedule. It isn't just a bar graph, it is a lot more complicated than that, especially for bridge work. That straight line for fabrication becomes a bell curve because of the process and prep work required to do big plate girders. But these are some of the things that we have to go through or that we take a look at going into a project. Everything is pretty straight-forward as far as material ordering. Detailing becomes pretty straight-forward unless there are some open questions that are usually resolved before the project is ready to start. Approval is straightforward. The biggest unknown in this particular schedule is when we are going to receive material. We can project four to eight weeks. That gives you a four week overlap. We have to have enough material to meet our commitments at the start. We don't need it all at the beginning, but we need enough to get started on a project, or we will never make our dates. Once we have done our preliminary and have started the material ordering process, we go to what are usually known as mill rolling schedules. All the red marks on this particular schedule are closed, or rollings that require inquiry. An inquiry means that they may be able to supply material, they may not. And the date is either subject to accumulation or your allocation. There are quite a few, especially in the wide flange sections and the heavy angles which we would use in bridge work, that could go out into that eight, even ten week time frame. This can blow your schedule wide apart. You will see the same thing, all the red circles, again, are items either that are closed out or require inquiry. Even the mini-mills that tend to have a little bit faster turn-around time. You can see the majority of the first rollings issued are closed. That can really throw your schedule into a tailspin. This doesn't even cover plate. There is no such thing as a rolling schedule per se for plate. We are very sensitive to plate work for the bridge market and that they don't produce a rolling schedule. You make your preliminary of the plates you require, size, grade, length, quantity. You submit that to the mills, and they will come back and tell you when they can fit it into their rolling schedule. They roll so many tons a week, and you just hope you can catch them in one of their off weeks so that you can get your material in a timely manner. There again, until you get back your acknowledgments on your mill rollings, especially on the plate, you don't know whether you will be receiving material in four weeks or in 12 weeks. Here again, it is a schedule restraint. It is something that you can't project. All you can do is find the fact and go from there. With these confirmations, you would think it would be a matter of a telephone call. Well, they can take upwards of two, and even stretch out sometimes as far as three weeks, depending on mill breakdowns or shutdowns or what is happening in the market place at that particular time.

Now to get a little more into material. I have prepared a slide that depicts what has happened to material as far as pricing goes over the last three years. The average price on structural shapes in 1986 was $25 a hundred weight. Plate was running at about $19 a hundred weight. In 1987 we saw a four percent increase in the structurals. That took them to $26 a hundred weight, and the plate went up to $21.25 a hundred weight or 11.8 percent. In 1988 we saw another increase in structurals that went up to $28.50 a hundred weight or a 9.6 percent increase from 1987, or a 14 percent increase from 1986. Plate in 1988 went up to $23.75 a hundred weight or 11.8 percent increase again over 1987, or a 25 percent increase over 1986. Now the reason that I just briefly wanted to touch on pricing is because it also goes hand-in-hand with the next slide that I am going to show you which has to do with lead times on structural steel for us to receive the raw material.

Part of the reason for these increases is purely a supply and demand curve. You had the big USX strike. There were some plant closings associated with that. You have a strong dollar, so the foreign market kind of went away. We just lost competition. Supply went down as far as availability of material because of some plant closings, and the strike, and the dollar made it less attractive to go foreign. So we are in a seller's market again. It is starting to soften up at present, but when I prepared this presentation, I was still looking. I didn't really know when project material would be rolling into our plant, and that was still at the eight to 12 week time frame. What this slide actually shows you is that the structural steel for 1986, 1987, and 1988 are all shown in blue. The red indicates plate work. Now the reason for the pointed curve is that you are dealing with a time frame of either four to six weeks or eight to ten weeks. You can see that in 1987 there was a kind of a jump halfway through the year on your lead times. We jumped in structurals from four to six weeks to six to eight, and we jumped in the plate work from four to eight to eight to ten weeks. This can really throw your schedule on a tailspin, especially when you are relying on placing orders after you have received a contract, after you are already committed to a schedule. Thank heavens, there are some sympathetic contractors and owners out there who do understand part of this problem. We don't really know how to get out of it yet, but what we try to do is the minute we find out we have a problem with material rollings we notify the customer, so that he can make arrangements to notify the people on down the stream from us.

The other thing that this particular chart does not reflect is that on mill rollings, you normally have on structural shapes, a ten percent reject rate of the material rolled. That is slightly higher than ten percent for plate work. That doesn't mean the mills are doing a bad job, I think it is just inherent in the beast. What we have seen, though, is that the mills are doing a better job of detecting the problems in their own material at the mill. In the past, the material would get all the way to the fabricator before the problems were discovered. This would include a two-week shipping time frame, which you would loose out of your schedule, then you would have to turn around and reorder and re-roll the material. One other nice thing that the mills do for us in their efforts to try to help us is that reject material does receive priority in the very next rolling. But the problem is the next rolling is another week so you have to add freight onto that, and you are still losing time as each problem occurs. You are also adding time that people don't take into consideration for any special test requirements. This comes into play, especially on bridges, where if you are requiring an out of the ordinary sharpie requirement, you usually want the plates tested for laminations. Anything you add to your specs for steel is going to add time to the mill's processing time before they can ship the material. Even today, even though we see a little softening in the mill's position due to some weakening of the dollar aiding foreign steel. The U. S. mills are trying to get back into the market a little stronger, plus increased capacity. The mills are now absorbed. USX is back on line. You have the mills running a full turn now. You are still seeing those rolling schedules change weekly. We are still going by a wing and a prayer on whether or not you are going to get in in a timely manner to support your fabrication cycle.

Now if we can remember the schedule that I showed you, the basic concept is to follow a sequence manner of producing a project. You order your material, you get your drawings done, you process those drawings, you go into fabrication. If, for some reason, your material does not flow in a manner to support your fabrication, it does a lot of things to the fabricator. You don't necessarily get just a direct extension of time for the material delay. If you are expecting material this week Monday and it doesn't show up until next week Monday, that can normally be absorbed in the fabricating and still meet your commitment. If we are expecting material this Monday and it doesn't show up for four to five weeks, what we have done is lost our time slot to fabricate your material. So you are not going to just say, ''Well, fine the material is late, we accept that, just ship us our bridge or our building five weeks later''. What has happened is that we also have project backlogs from the shop loading. You can see that we like to keep a three to four month backlog. We are now interfering with other projects. You have now impacted something else. We have to absorb that either through overtime or start scattering around other projects to other facilities. Any time delay costs somebody money. Normally, it costs us money because of the added overtime, and the shipping charges, and the things we have to do to try to get the work done on time, because our reputation is basically a big share of our livelihood. It gets us more work and keeps us productive. That is the only way that I can see we can work our way around this jointly or sharingly, because it is not always the fabricator. You talk about detailed drawings, you talk about engineering problems, you talk about drawing approval. I feel we are in that very closely with the owner/engineer. You talk about the mills. You are usually talking about big corporations. If you don't buy their steel, somebody else will. To meet schedule requirements it is not always a viable alternative to go to a warehouse, because it is cost inhibitive for a fabricator who didn't include that in his competitive bid. You can see upwards of 30 to 35 percent increase in material, which runs approximately 40 percent of your total project budget. You can see where the fabricator can't consistently afford to do that either.

What I have tried to do is outline in my opinion, several ways in which we could try to get around this material problem. They all lean very heavily in trying to get the material orders placed as early on in the project design concept stages as possible. Now what that does for us is it allows for mill rejects, shutdowns, 10 to 12 week lead times, because even after award, it takes a fabricator four to five to six weeks just to gear up to start fabricating your project. If you can order the material four or five weeks before you are ready to award a contract, then you have material there when he is ready to go to work, and everything should run fairly smoothly. But at least you have some flexibility for change.

The first items that I would like to discuss are the options in trying to get that material ordered early. And I can't stress early enough. I am talking about what a design engineer can tell you what size sections you need or what size plates he plans on, specifically about bridges. If he could tell you what his flanges are going to be, what his web is going to be, those are going to be the key items. Those are going to be the long lead time on mill rolling items.

The first item that I have are ways around the material problem. You can purchase it yourself. If you are an owner or a railroad you can go out and buy that. You can stockpile that material yourself. It will get the material on stream quicker, but it will mean you have to stockpile it someplace, and you will also have to have experienced staff who knows the ins and outs of ordering that type of material and trying to get leverage in the market because you are going to be in competition with some people who buy a heck of a lot more steel than you would. You are also going to look at a considerable cash outlay for all that stock that you are going to have lying around waiting for that project to go. There are some advantages to buying it yourself though, because you have a potential cost savings to a certain extent if you do it right. No matter whether you are a fabricator or a warehouse, the published mill prices tend to have some types of discounts for either quantity or just the marketplace. It is just like going to J. C. Penney's and buying stuff on sale. That tends not to be that big a deal. You also have to be very careful if you are buying your own material because you also have opened yourself up for a bigger liability as far as to the fabricator, because now you are responsible for making sure his shop isn't empty because you can't provide him with the material. You also have to make sure the quality requirements of the material are correct. That all goes back to that staff issue. An advantage is you can, at least in your inquiries, or even in your contract, tell the fabricator when he should be receiving the material. He can then put a firm schedule together for you, and you can plan out the rest of the project. Hopefully, if you can order that material four to five weeks earlier than a fabricator could, you may be able to eliminate the variability of the project schedule.

The second item, and I doubt that you would get this from most fabricators, is you could develop a relationship or an agreement with a warehouse itself. Now, a warehouse, because of its buying power, could make an arrangement when you know what material you need, he could bring it in for you. He could place the orders. You do have some time to designate where you want your material shipped. That can buy you another couple of weeks, but at least you are slotted for a specific rolling, and you can get it on the mill's logs to get produced. Granted, there will be some cost increase because you are going to pay the warehouse for doing that paperwork for you, or if it comes to that point, of even storing that material for you. But at least it is in the hands of the people who really know how to deal with these particular items. You are still going to carry over some of the increased liability for providing the fabricator with the material on time, because the fabricator is not responsible for it. So if the warehouse falls down and you don't get that fabricator the material when he needs it to start his fabrication, you are going to be liable for some impact. But I think the advantage of going to a warehouser would have some cost savings, because he, again, is going to buy the material below what the standard mill cost would be to you. However, you are probably going to eat that up in what you are going to have to pay the warehouser to handle it for you. The warehouser should be able to make sure that you have your material provided with a good quality and acceptable quantities. And there again, this is just one other item that would eliminate the material variable in your project schedule.

The last item is nearest and dearest I think, to my heart. Some bigger companies don't like the term "negotiate work", but it sure would help to eliminate a lot of the material problems. I am not saying that you go and do all your work with one specific fabricator, but if you could get a fabricator on line early enough in the project and negotiate his price, whether it be the so-called unit price method or a fixed labor fee and you pay for his labor, there are all kinds of options to go ahead and negotiate the contract work. It would allow that fabricator to come in and start ordering material while you are still in the preliminary design stages.

One aspect I didn't even put on the slide, because I wanted to talk about material. Fabricators tend to have good ideas on how to fabricate steel cheaper. It will also give you that avenue during the initial design stages. There would be the potential for some increased project cost, and that is only if you are not doing your homework and not negotiating with good, reputable fabricators. I don't think if you were to rotate the people that you do business with, which has been the common practice with people we have negotiated with, that you are going to find any real increase in your actual project cost. You are still going to be able to buy for the lower dollar, because you will probably negotiate with more than one fabricator. But the advantage to negotiating on a project-by-project basis is that you would eliminate one of the bigger problems which the fabricator would be responsible for making sure the material shows up in enough quantity and in a timely manner for his fabricator and in the proper quality.

I guess the added benefit is that you could generally save costs that could be realized through fabricating/engineer communications. You know, as I mentioned before, it is just a really nice way to go especially with the lead times we are looking at in material. I know accountants tend to think that there is coercion or whatever when you start talking negotiation in projects. I think with the fabricators that are still out there and even the new ones, if you negotiate properly, you keep changing the people or double checking the people or even throwing in a competitive bid project once in a while, you will know what your bridges are going to cost. But in the long run when you start talking about a bridge being five weeks, two months, three months late and the field cost generated by not showing up when you have a field gang out there or even scheduling things into winter work, I think you will find that what little cost increase there may be in negotiating work is going to be more than saved on the other end of the project. I thank you for your attention. (Applause)

Mr. Tallent: Sid, with some of the delays in the steel coming from the mill, are you seeing some of the more simple fabricating work being done in the field by the contractor instead of coming into the shop to cut down on this time delay?

Mr. Blaauw: Basically, our experience is that we will do very little work in the field. Even if the material is late they would still rather save their dollars and have us do it in our shop. Now that all depends on what type of project you are talking about. If you are talking heavy weldments or heavy welding in the field they can probably do it almost as cheaply as we can. Our expertise is when you are talking about fit up, pieces and components coming together, small layouts. Trying to lay out things in the field tends to be a little tough. But predominantly, people like to see the fabricator do as much as he possibly can before it goes out the door. You end up, either pay me now or pay me later. It is still cheaper to do it in the shop than in the field. If you are talking about that scenario, where there is already a gang out there, then it is probably cheaper to let those people keep working instead of going home and paying them shelf time for nothing.

Mr. Kapp: Is there a slow period for the shop always in the early part of the year or does it vary with each shop each year?

Mr. Blaauw: Well, again, from our experience, we have been on overtime for two and a half years at one phase of our shop. Now, what that means is that we have been very fortunate. We have been tincanning our way through, but historically you will find that fabrication of structured steel is usually very busy starting March through the summer and slows down in the winter months. You will find that very true of what I call local fabricators, which we were a short a time ago. We have now changed our market place and now go all the way across the country, so we are not as seasonal as we used to be. But historically, if you want your bridges made, winter would be a great time because that is when your shops tend to be empty.

Mr. Horney: Sid, thank you very much. I think that was a good insight on some ideas that maybe we hadn't thought about while we were out there wondering why the steel hadn't been delivered.

As I mentioned earlier, there are three standing committees within the B&B Association. I would like to have Chuck Thompson come up to give our second report. Chuck is chairman of the training committee and will give you a quick summary on what we have been doing during the last year.

STANDING COMMITTEE — TRAINING

Update

Mr. Thompson: Thank you, John. My report will be very brief for what we are trying to do here. Our objective is to build up a reference index of where to obtain material or information from companies or individuals who are employed by these companies. In this manner any member seeking special information may get in touch with the Secretary of our Association, and she can pass on to them the name of the company or the person from whom they could get the information required. We are asking companies or individuals to send a list of films, pictures of projects that have been completed, or papers that have been presented at other times and places to the Association's Secretary. The reason we are asking that only lists be sent and not the material to the Association's Secretary is because the Association office is too small to accommodate all the material that may be sent in. You heard President Lewis say that when the Auditing Committee came in with three people they brought their own folding tables, and when one wanted to get up they all had to get up!

For example, CP Rail has a seven-volume set of handbooks containing information on driving piles, installing culverts, replacing steel or wooden bridges, glossary of the names of the components which make up steel spans, and much more information. These volumes were prepared by B&B Masters, Engineers, and Technicians, much the same as the papers are prepared for presentation at the conference we are now attending. I have permission from our management people to make all or part of these volumes available on a loan basis to anyone who can use this information.

Also I have a list of books and a publishing house that lists books on almost any subject for which you require information. Alternately, our Assocation conference Proceedings can provide a wealth of information on several different subjects. If you see an article in a trade paper or a magazine, please let the Association Secretary know, so that it can be listed with the other material that is being assembled. For instance, I recently read an article in "Today's Supervisor" entitled, "Plain Talk about Fire Extinguishers", which contained much useful information. So, fellas, if you do have this type of information that you think is of value to others, by all means send a list of what you have to the Secretary, and she will catalog it into a list and keep it in the office, and anyone wishing to get information on a certain subject can talk or write to her, and she can pass the information on. Thank you. (Applause)

STANDING COMMITTEE — EQUIPMENT

Update

Mr. Horney: Thank you, Chuck. Are there any questions about what we are attempting to do with our training program? Our third standing committee dealt with equipment and our friend, Leroy Davidson, is chairman, but Leroy is out with the ladies this afternoon, so I will give his report for him.

Leroy sent a questionnaire to 25 railroads across the country asking them about what their needs and desires would be for equipment. Six subject areas were addressed on this questionnaire such as what do you need in pile driving? Do you have new equipment now? Do you need any more new equipment in this area? Or have you gotten any recently? Along with pile driving the same questions were asked for equipment regarding inspection, excavation, painting, bridge span replacement and installation of deck span ties.

Seventeen of the 25 respondents, 50 to 64 percent, said they didn't need any equipment. A smaller percentage, 12 to 18 percent, said they definitely needed equipment and the highest percentage said they needed their equipment in the bridge inspection area. There was a pretty good group of about 24 to 30 percent that said they had just gotten equipment in these areas. So that tells us what the railroads are looking for and have budgeted for. It also tells us they have received some new equipment and are not really looking for a whole lot more in the near future.

Briefly, the following are comments received from the questionnaire on equipment that is needed to improve efficiency and safety.

For pile driving, they are looking for equipment to handle longer piling.

On inspection, they are looking for a three-armed hi-rail vehicle and metal fitness measuring device. I think something like that is available now. Cherry-picker-type trucks are wanted for bridge inspections and faster, thorough inspection equipment, inspection vehicle with a work platform or device to inspect I-bars and pin connections in truss spans.

In the excavation area, the railroads are saying they are looking for backhoes with a front end loader and for safe, efficient and easy installation and removal of shoring material. Most comments indicated that excavation equipment is leased or rented.

For the bridge span equipment or replacement, comments for those areas involved a need for equipment to handle heavier spans. I think Norfolk Southern is looking at taking a derrick and a 150-ton wrecker and modifying that wrecker with a longer boom to be able to utilize that for setting heavier spans. The replacement of older cranes with larger new cranes was mentioned.

For painting equipment they are looking for surface preparation equipment other than sand blasting.

For installing open deck spans, they are looking for a tie handler similar to track equipment and equipment to minimize track time required.

Additional comments were that they are looking for equipment to improve culvert inspections.

So from the equipment standpoint those were some of the results that we have come up with this year with our standing committee. For the agenda next year, we would like to have a detailed report in the equipment field. Are there any questions? If not, I'll turn the program over to President Lewis. Don.

President Lewis: Thank you, John, for looking into our three standing committees and having reports on each one of them. For our final presentation I would like to ask Byron to come up and present the speakers.

Mr. Burns: Thank you, President Lewis. John mentioned inspection vehicles. I think the next presentation will fit right in with that. Our last special feature this afternoon is titled "Bridge Inspection Cranes". Mr. John Stubenvoll of Reach-All and Mr. Lars Lundberg of SRS-America will each present the type of crane developed for this purpose by their respective companies.

Our first speaker will be John Stubenvoll, product manager, Reach-All. Mr. Stubenvoll.

BRIDGE INSPECTION CRANES

John W. Stubenvoll

Product Manager, Reach-All

and

Lars Lundberg

SRS-America

Thank you. I would first like to start off by telling you a little bit about the company. Reach-All is located in Duluth, Minnesota. It began in 1964 when we built our first aerial device, or cherry pickers, as they were called then, to be used for trimming trees around the power lines for the power companies. Today we are a leading manufacturer of aerial devices and hydraulic equipment for the utilities, the state highway departments, the railroads and the United States government, with over 7,000 machines in service today. We have a modern facility in Duluth, with 160,000 square feet of work space and 150 employees. So we have the ability to expand and innovate as the market changes.

One of these changes occurred in 1983, when we were first contacted by the State of Wisconsin Department of Transportation. They asked us to assist them in the development of a bridge inspection unit. They had problems with their bridges and getting their inspectors underneath these bridges because they were getting wider and deeper and higher off the ground and water, and there was nothing available at the time to accommodate all their state and interstate bridges. So we began then to develop a new generation bridge inspection unit. These units had to be faster and safer and, most importantly, had to have more versatility and longer boom lengths. As a result, working with the State of Wisconsin, we developed their model UB 60. Today, this is still the largest bridge inspection unit manufactured in the United States. It is also the largest in the world of a system that doesn't use outriggers for stability. As time went on we began working with other states and even started to work with some of the railroads, and we developed a complete line of bridge inspection units, primarily for the state highway departments at this point. We have various options available and various different lengths available to accommodate different bridges. We found out that some of the states had similar problems to Wisconsin but they also had their unique conditions, where they had some bridges that needed something a little different. I brought a film with me today that is about 10 minutes long, and it talks about our UB series product line. The design and features you will see in this film aren't necessarily a result of our engineering staff alone, but were a culmination of effort between the highway department engineers and our engineering staff. Please start the film.

(Whereupon there was a film presentation)

Mr. Stubenvoll: I realize that the film is geared toward the state highway departments, because that is where we got our start, but the concept and the features that you see on the film are something that we have begun to carry over to the railroad industry. We have built a machine specifically for the Washington area metro system, and as the film points out we take the basic concept, and we can customize it. We offer various work platforms. You will notice on the film there was an inspection platform which is standard. We have gone up to eight foot wide work platforms that rotate under the bridge. I realize that Reach-All is probably a new name to most of you and that should encourage you to take a closer look at us. We encourage you to work with us, and together we may be able to develop a machine specifically that might fit your needs. Are there any questions that have come up as a result of that film?

Member: What is your arrangement for working on hi-rail? Do you lock out on the rails, or do you run similar to the SRS system?

Mr. Stubenvoll: Well, the machine we built, and again we put quite a few highway machines out, we are just getting started in the railroad industry, so we have one to talk about and that was set up on hi-rail gear. It does not need rail clamps, and it does not use outriggers. We still use the counterweight system. We do use the spring axle locks. It is mounted on a conventional truck. All four axles are locked up, and then there is a ten-inch I-beam sub-frame that runs the full length of the truck. This takes out any kind of twist. So we can eliminate outriggers or clamps. It was designed to operate and move on the rail while they were inspecting. We did, in that case, put in a reversing gear, so it can run in reverse as well as forward. In their application, they have a short amount of rail that they are running on, and that worked best for them. We are presently talking with some companies about different types of carriages for these machines. But we do want to keep the concept of no outriggers and a counterweight that stays in the truck bed.

Member: When you work from rail, can you work on both sides of the bridge or only the right side like you did on the highway?

Mr. Stubenvoll: Most state highway departments don't want to work off of the lefthand lane and they like to do everything from the righthand lane, so we can reach up to 60 feet from one side. We have talked about shortening that and being able to work off both sides, because in your case I'm sure we don't need that kind of length, and we can just shorten up the booms and as on our model UB 40, which is fairly short, work off both sides. Any other questions? If not, I would like to thank you for your time and Mr. Burns for inviting me here. We welcome the opportunity to work with anyone of you to develop a machine from these models that we have available that might work best for you. Thank you. (Applause)

Mr. Burns: Thank you, Mr. Stubenvoll. Next we will hear from Lars Lundberg. Mr. Lundberg is a civil engineer from Sweden. He has practiced in this profession since 1969 and has worked in the area of railroad applications since 1973. I would now like to present Mr. Lars Lundberg.

Mr. Lundberg: Thank you, Mr. Burns. I am Lars Lundberg with SRS-America. You will experience some strong Swedish accent, but I hope my technical information will get through.

I am here to feature the SRS over and under bridge inspection and maintenance vehicle, colloquial named ''Over and Under''. And, of course, it is also interesting for me to experience more about the Reach-All inspection crane. This is the SRS Over and Under bridge inspection vehicle built on a Volvo F7 chassis and equipped with our hydrostatic powered hi-rail system. The main dimensions are weight is 26,000 pounds, that equals to 12 tons. The overall length is 29 feet and maximum width is eight feet, the overall height above road surface is 12 feet 7 inches and the overall height above track level is 13 feet 6 inches, and the maximum payload is 2,200 pounds. That is equal to one ton. The maximum payload in the working platform or the basket is 480 pounds.

It is powered with a 175 horsepower turbo diesel, and the maximum speed on the highway is 55 miles per hour and on track 45 miles per hour in both directions. So utilizing experience gained in more than 15 years of operating regular hi-rail vehicles equipped with a vertical adjustable platform, the Swedish State Railway in cooperation with SRS designed this new Over and Under bridge inspection vehicle. The basic requirements for the new vehicle were: the platform should be capable of multi-directional moving and designed in such a way that it eliminates dangerous climbing. At the same time that platform should provide a stable and safe working area. The vehicle should operate without outriggers, rail clamps, or similar devices. But it should be capable of high speed travel both on rail and on the highway as well as through switches and road crossings. It should be capable of quick changes from road to rail traction or vice versa. The system should provide a safe working condition within the entire operating envelope and the vehicle should shunt the signal system but there should be an installation option available. The system should be possible to operate and drive from the working platform in safe speeds. There is no need for a permanent driver in the cabin. There should be an electrically powered emergency system from the 12-volt battery to get the basket in transport configuration in case of main engine failure. The vehicle should not foul the adjacent track when entering or leaving a double track, and the basket should not rely on gravity for being in level. There should be outlets for pneumatic, hydraulic, and electrical tools in the basket.

In order to meet these requirements it was obvious that the method of rail travel had to be an entirely new concept. It was decided early that the new bridge inspection vehicle should be mounted on the same chassis and using the same hydrostatic drive as we successfully used on the SRS sky lift in Sweden. Since the introduction of this under and over concept it has greatly improved efficiency of inspection and maintenance of railroad bridges and overhead structures in both North America and Europe.

When on road the SRS bridge inspection vehicle operates as a normal truck. The rail wheels are up about two feet from the road surface. On rail the system is operated from the cab during transportation and from the platform during inspection. From the basket the vehicle can be operated at the maximum speed of three miles per hour in both directions. The maximum speed on rail when operated from the Volvo cabin is 45 miles per hour in both directions. The engine can be started or stopped from the basket.

The following four pictures will describe how to enter or leave track with a patent SRS hi-rail concept. We enter or leave tracks very smoothly at nearly any road crossing without intruding on parallel tracks. Our hi-rail system enables us to use road crossings only a little wider than the vehicle. When entering the track we position the rear end bogie over the track. We turn the bogie, align to the track and we lower it by the hydraulic system. At the same maneuver we lift the rubber wheels from the road surface and shift to rail drive. Now it is time to align the trunk end to the track and we still use the front rubber wheels for that. When the vehicle is in position we finally lower the front rail axle, and the entire machine is now resting on the steel rail wheels for maximum traction and brake capacity. We have independent disc brakes on all rail wheel axles. So the whole operation to put the Over and Under on track takes about three minutes.

I will now briefly show in what range we can operate SRS Over and Under inspection crane. In this view we can see the operating range when moving the basket underneath the bridge. The bottom on the basket is approximately 11 feet below top of rail in this view, and this drawing is in metric, but to convert, one square is approximately three feet three inches. Vertically the four piece multi-directional arms reach 24 feet 6 inches straight down and 18 feet above top of rail.

The following pictures are a sequence showing the movements of the boom. This picture shows the basket in its lowest position. That is 24 feet down from top of rail.

This is in the highest position, 18 feet above top of rail.

This is underneath and on the opposite side from where the basket started on a single track bridge. Also note how the axle lock keeps the vehicle in level.

This is the same as the previous picture but this time on a good old American bridge.

I will only give you one more dimension in this presentation and that is for the aluminum basket. It measures three feet three inches by four feet, and as I mentioned earlier, there are outlets for pneumatic, hydraulic, and electrical tools. I will conclude my presentation here. If you have any more interest in our machine I will be happy to answer questions now or later. I also have some technical information and brochures available. So thank you very much for listening. (Applause)

Mr. Thompson: You say there is a leveling device. Say you are on elevated track with that on the low side with your basket, you say the truck levels up?

Mr. Lundberg: We cannot go over three inch superelevation on the low side, but on every piece of track we are in level to the track. We keep the springs from working.

Mr. Burns: The accessory electrical, is that only 12-volt truck voltage or is that available in whatever AC current you specify.

Mr. Lundberg: The normal 12-volt from the 12-volt system. We have an option used for a couple of railroads over here, with a generator for the 110, 125, or 220 voltage.

Mr. Burns: Are there any more questions? Thank you, Lars.

President Lewis: Thank you, gentlemen. I would like to advise you that there are copies of all the Bridge and Building subjects available in the back of the room. There is no charge for them. At this time we have reached the point where if there are no other special announcements we will adjourn. Be sure to meet your friends this evening at the reception sponsored by REMSA. It will be in the Grand Ballroom between 6:30 and 8:00 p.m.

Tomorrow morning we will meet again with the Roadmasters for the final joint session at 8:30 a.m. in the Red Lacquer room. This meeting is adjourned.

Adjourn

WEDNESDAY JOINT SESSION

September 21, 1988

President Snyder: Ladies and gentlemen, we will now call this final joint session to order. Our thanks to REMSA for the wonderful reception last night.

At 8:00 a.m. this morning our registration stood as follows: Roadmasters 181; B&B 137; Associates 207; Guests 104; and Ladies 75, for a total of 704. This compares with a total of 735 at this time during our conference in Kansas City last year.

I would now like to have Jerry Cossel step up to the podium. Jerry has been our Treasurer for the past year and has done an admirable job. Like all Treasurers in our organization he turns from an optimist to a pessimist, and what I have always said about that position is more than one pessimist got that way by financing an optimist. Jerry, on behalf of the Roadmasters Association I have a plaque for you which reads as follows: "Appreciation Award presented by the Roadmasters and Maintenance of Way Association of America to Jerry Cossel for his services as Treasurer 1987-1988". Thank you, Jerry. (Applause)

I will now turn the podium over to Don Lewis. Don.

President Lewis: Thank you, Ray. At this time I would like to call Don Steele to the podium please. Don has been a director for the past three years and this year he has had the registration desk and has taken care of giving us all the counts of attendance at these meetings. This plaque from the American Railway Bridge and Building Association reads, "This plaque is presented to Donald L. Steele for his services as Director 1985-1988". Thank you, Don. (Applause)

Now I would like to call Mark Walbrun to the podium, please. Mark has been a director for the past three years and he has been responsible for our quarterly newsletters and has put a lot of new innovative things into it. We supply bits of information and try to pass this on to our members. The plaque for Mark reads, "American Railway Bridge and Building Association presented to Mark C. Walbrun for his services as Director 1985-1988". Thank you, Mark. (Applause) As some of you may know, Mark has been nominated and will be installed as one of our new junior vice presidents also.

At this time I will turn the program over to Byron Burns who will introduce our first special feature this morning. Byron.

Mr. Burns: Thank you, President Lewis. I will ask Jim Michel of Amtrak to say a few words about our first special feature this morning. Jim is senior director engineering design with Amtrak. He is a member of the American Railway Engineering Association Committee 6. He is also a past Director and is currently chairman of the Proceedings Committee of the American Railway Bridge and Building Association. It is through Jim's efforts that the French government allowed this film to be shown at this conference. Jim.

Mr. Michel: Good morning, ladies and gentlemen. Several years ago many of these railway engineering conferences featured movies and technical presentations about the new French high speed passenger trains under construction between Paris and Lyon. The letters TGV and the sleek orange train sets have since become synonymous with high speed passenger train travel. We were in awe at the routine nature of 160 miles per hour travel on rails.

In 1984, the French government authorized the construction of a second TGV system called TGV-Atlantique. Construction has been proceeding on this new system to the west of Paris, with revenue service to LeMans scheduled for next year and to Tours in 1990. TGV-A is different in that it had to build a new line into the heart of Paris. There are also numerous tunnels and bridge structures.

Today's presentation from SNCF is a film made in late 1986 showing the civil engineering works. These are now largely completed with track laying, signaling and electric traction construction underway. This film will acquaint you with this exciting project. (Whereupon there was a film presentation)

Mr. Michel: Originally we had hoped to have a new film just completed this past June on the TGV-A Bridges and Tunnels that would show you many of these structures already in their completed state. However, the sound track for that film has not yet been converted to English and my ability to give you a simultaneous translation is rather limited. This film concludes with "to be continued." We hope that perhaps at our Toronto conference next year we will have this film in English or perhaps my French will be a little better. TGV-A is the second system. The French have already authorized a third system, TGV-North, which will connect Paris with the new channel tunnel, with an extension into Brussels and Northern Germany. I wish to thank Mr. J. P. Bernard and Mr. Jack Duchemin, special counsel for railways at the French Embassy in Washington, for assisting us in getting this film. Thank you. (Applause)

Mr. Burns: Thank you very much, Jim. It is now my pleasure to introduce our next speaker, Mr. Paul Saletnik of the Chicago and North Western Transportation Company. Mr. Saletnik received his Bachelor of Architecture degree from the University of Illinois at Chicago in 1974. He has been a member of the Chicago and North Western's building department since July 1974 when he started as an engineering department management trainee. Since then, he has held the positions of staff engineer of buildings and assistant engineer of buildings until promoted to his current position of engineer of buildings in December, 1981. He is certified by the National Council of Architectural Registration Boards and is a registered architect in several states in which the Chicago and North Western operates.

Paul served as a director of the American Railway Bridge and Building Association from 1979 through 1981 and as Treasurer of the Association from 1982 through 1984. He is also a member of Committee 6 of the American Railway Engineering Association. May I now present Mr. Paul Saletnik.

PROVISO DIESEL SHOP ADDITION

Paul H. Saletnik

Engineer of Buildings
Chicago and North Western Transportation Company

The new diesel shop addition is located just west of Chicago in Proviso Yard, CNW's main classification yard. Although the 560 acre yard is actually located in four suburbs, Bellwood, Berkley, Northlake and Melrose Park, the diesel shop is located in Melrose Park, Illinois.

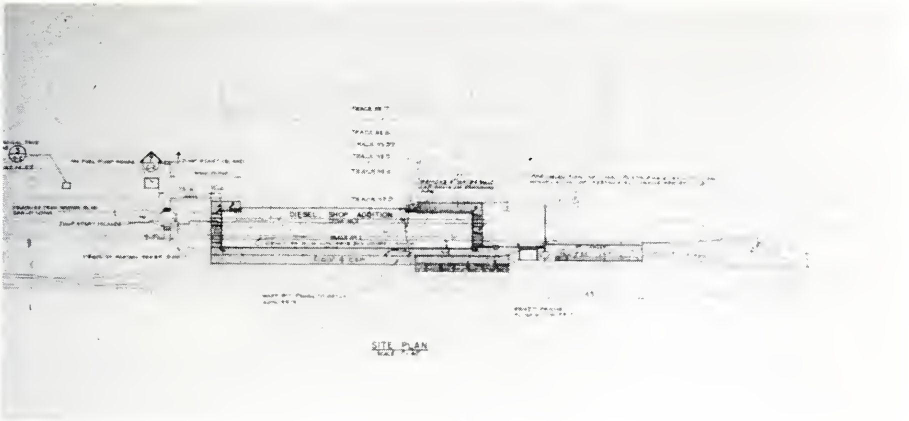
We broke ground for the new building only 11 months ago on October 20, 1987. CNW was especially proud because its Affirmative Action Program had achieved a milestone that day. The $4.1 million building contract award to Powers & Sons Construction Company, Inc., was the largest single minority contract ever awarded by the CNW.

Background

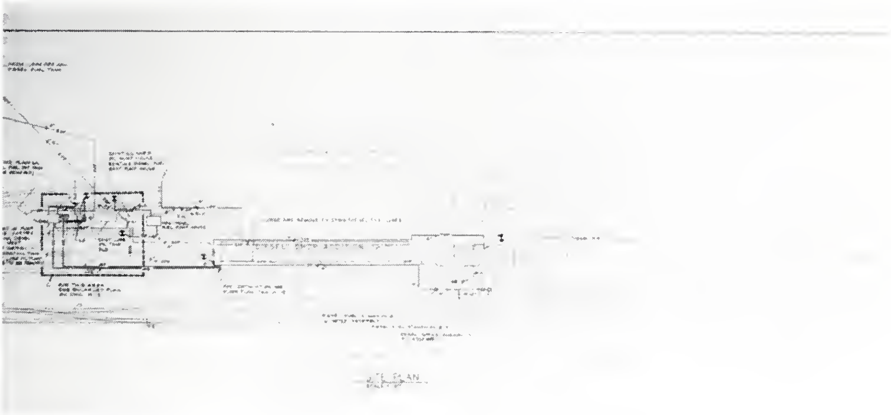
Before we get into the details on the construction, let me give you a little background. The original diesel shop was built in three stages. The first stage (Low Bay) was constructed in 1948. It is a 64 foot wide by 234 foot long, two track masonry building, with depressed floor, inspection pits, 29 foot wide center work platform, five foot wide side platforms, with toilet, office and support facilities. The underside of truss to top of rail is 22 feet 6 inches. Under side of ceiling to top of rail is approximately 28 feet. Raised platforms are four feet nine inches above top of rail and inspection pits are four feet deep.

The second stage (High Bay) was constructed in 1950 and is 60 feet wide by 234 feet long. It is also masonry and houses two service tracks, one of which is a through track and the other stub ended. A full truck drop table serves both of these tracks with a center stubbed end release track in between them.

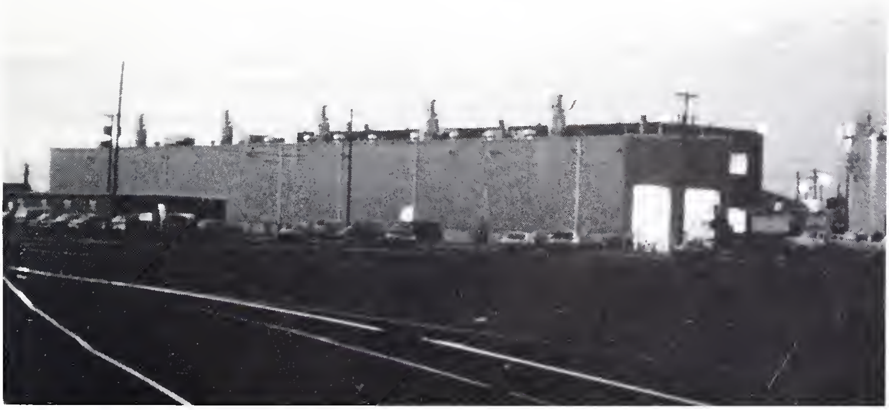
The run-through track has raised platforms on either side and the stub ended service track and release track floor is flush with top of rail.



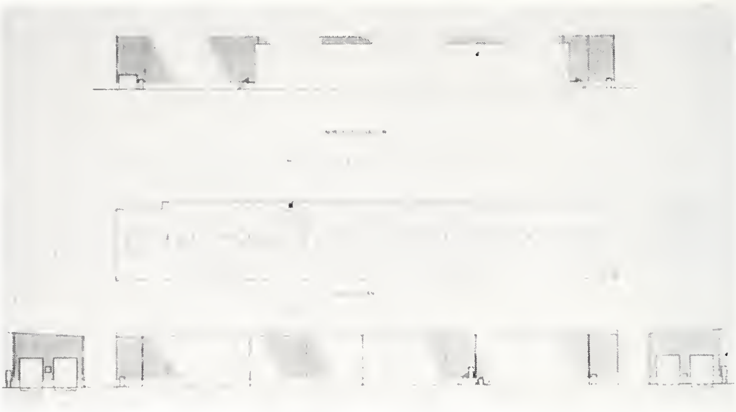
Site plan.



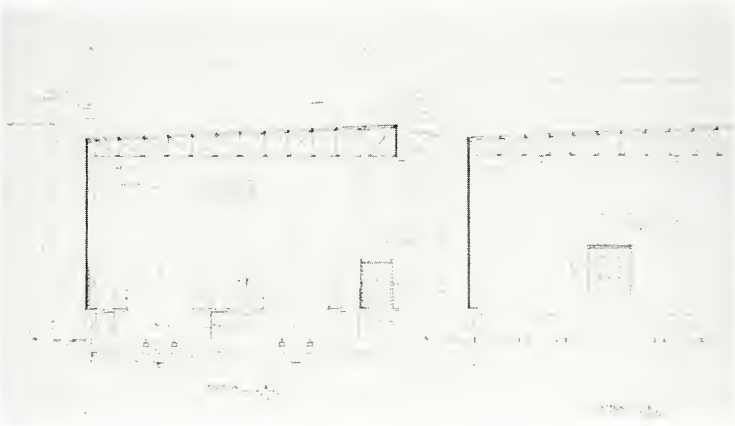
Site plan showing exterior piping.



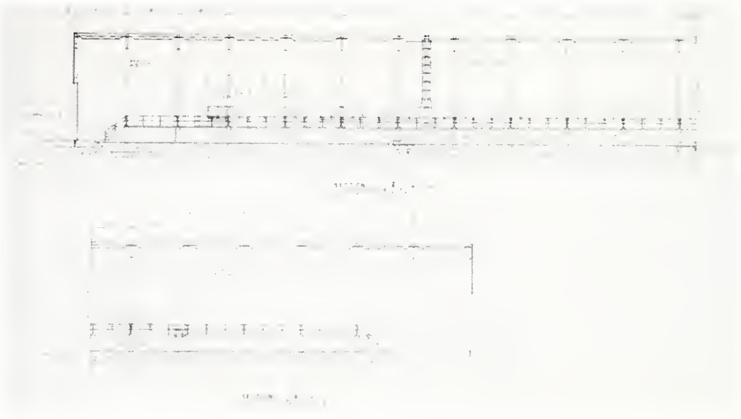
Exterior view from southeast.



Exterior building elevations and roof plan.



Cross sections.



Longitudinal section.

Both service tracks have continuous four feet deep inspection pits. The underside of truss to top of rail is 40 feet seven inches and underside of ceiling to top of rail is 46 feet. The entire length of High Bay is served by a 30-ton overhead crane.

Third stage of the original construction is a 32 feet wide by 200 feet long by 20 feet high lean-to metal building addition built in 1963 to house a locomotive wheel truing machine.

Problems with the existing construction included an inoperative lube oil drain system, no built-in provisions for reclaiming or recycling engine cooling water, or draining sanitary waste, poor ventilation, heating problems in the lower level areas during the winter season, and constant cleaning required to maintain gas-fired unit heaters.

In addition, locomotive fueling and sanding were done outside, east of the existing shop, which necessitated locomotives to be respotted several times in order to complete required servicing. First, each locomotive had to be spotted twice (one for each sand bin) under sand towers located at the far east end. Then locomotives were spotted at the fueling station immediately east of the shop and spotted again inside of shop to complete daily inspection and servicing. This constant respotting was very time consuming and necessitated a great deal of extra manpower to keep hostling locomotives back and forth. This method of operating also required a large labor force to separately man fueling, sanding and servicing facilities.

In the new addition, we combine fueling, sanding, and servicing into one facility, creating one stop servicing and only one facility to staff. Also, by establishing a quick one-stop service station in the new addition, the low bay of original construction is freed to provide additional medium and heavy repair space. As a result, total locomotive through-put at Proviso is therefore increased thus allowing further efficiencies by consolidation of various outlying locomotive service points.

Review of Site Plan

The new diesel shop addition was built south of the existing shop. Vacant land was available to the south, and it was in closer proximity to 19 and 20 mains which was an obvious plus from a yard operations perspective. Building to the south made locomotive access simpler and also minimized the extent of required track work. Land to the north is the current diesel shop material storage area which in turn is just southwest of the system material distribution warehouse. Current material flow into shops is along east road from north to south.

In this site plan, tracks one and two are the new building; three and four, the Low Bay; five, five and a half and six, the High Bay; and track seven, the wheel truing building. Diesel shop trackage also includes both a north and south run around track. The narrow wing extending to the west houses locker and toilet facilities on the lower level and lunchroom, administrative offices, and tool crib on the second floor.

Although building to the south was ideal from a functional and operational perspective, it did necessitate some additional work:

- Demolition and relocation of locomotive wash facilities.
- Demolition of approximately 400 feet of six feet by six feet concrete box culvert and replacement with approximately 600 feet of 66-inch corrugated steel pipe.
- Filling in approximately 600 feet of open ditch and replacing with an extension to the above 66 inch corrugated steel pipe.

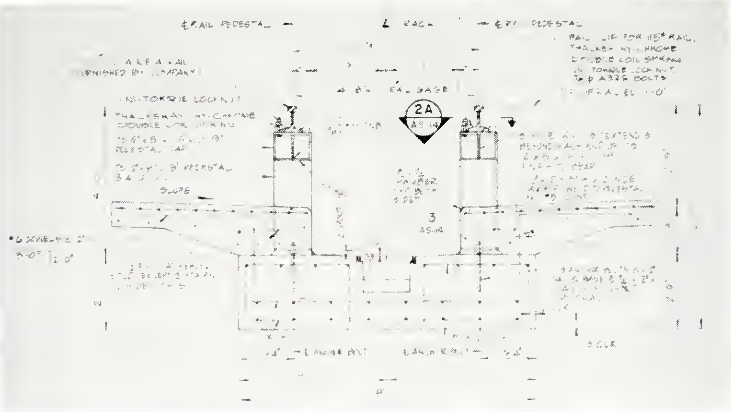
Since two of these items were a part of an existing drainage way handling storm water running from the City of Elmhurst and the Tri-state Tollway to Addison Creek, work had to be approved by the Illinois Department of Transportation, Division of Waterways.

Additional work items included:

- Shifting 19 and 20 mains south.
- Constructing a new 18-inch industrial waste sewer line loop around new building to replace existing 10-inch and 12-inch line running under new building site.

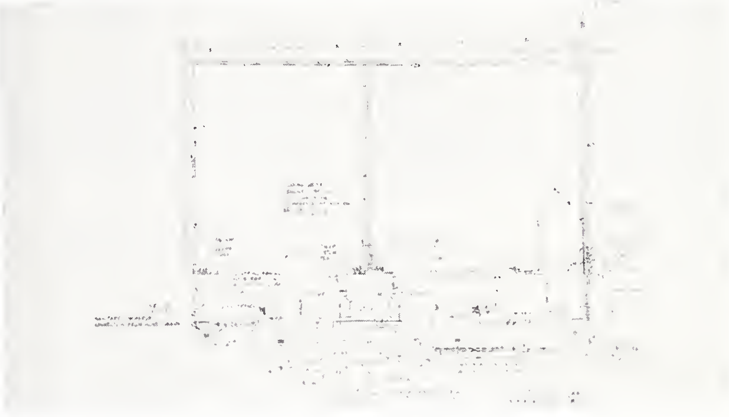
The rerouting of industrial waste line and construction of new industrial waste line serving relocated wash rack both required permits from the Metropolitan Sanitary District of Greater Chicago.

- Relocation of an electrical power distribution line in order to allow 19 and 20 mains to be shifted.
- Construction of a temporary diesel fuel line to serve existing stanchions at east end of existing shop.
- Purging and removal of existing six inch and four inch fuel lines running under new building site.



Inspection pit cross section.

Interior view.



Cross section showing piping.

In addition to the construction of the new building, the scope of work also included a two-spot fueling facility for yard engines, sand unloading, storage, and conveying facilities, an air compressor building solely serving the standing systems, a new fuel oil pumphouse, modifications to existing east fuel oil pumphouse so that it could serve as back up to the new one, and conversion of the west fuel oil pumphouse into a lube oil and journal oil pumphouse. The existing 20,000 gallons a day fuel oil tank and old metal lube oil pumphouse were also removed.

The city of Melrose Park required the entire existing building to be sprinklered together with the new construction. This necessitated construction of a new eight inch fire protection main serving sprinkler system, together with fire hydrants and a looped eight inch main around the new building.

Lube oil, sanitary waste, and locomotive coolant drainage systems, were also added to the existing shop, together with a locomotive cooling water and recycling system.

A major operating change that was also put into effect as a result of this project was the installation of locomotive spotter circuits on all CNW high horsepower locomotives and the decision not to run locomotives inside any CNW diesel shop. Units are moved into shops by power from its own battery being utilized by one traction motor. One locomotive equipped in this manner can move as many as four or five locomotives besides itself.

Battery start-up stations are provided on the outbound side of the shop should a weak battery be drained by the move into and out of the shop.

Not running locomotives in the shop means no more contaminated air, no more soot and dirt build-up on building walls and ceiling. After corn cob blasting and painting everything white, a higher ambient lighting level is created. The real savings, however, are in the reduced ventilation costs.

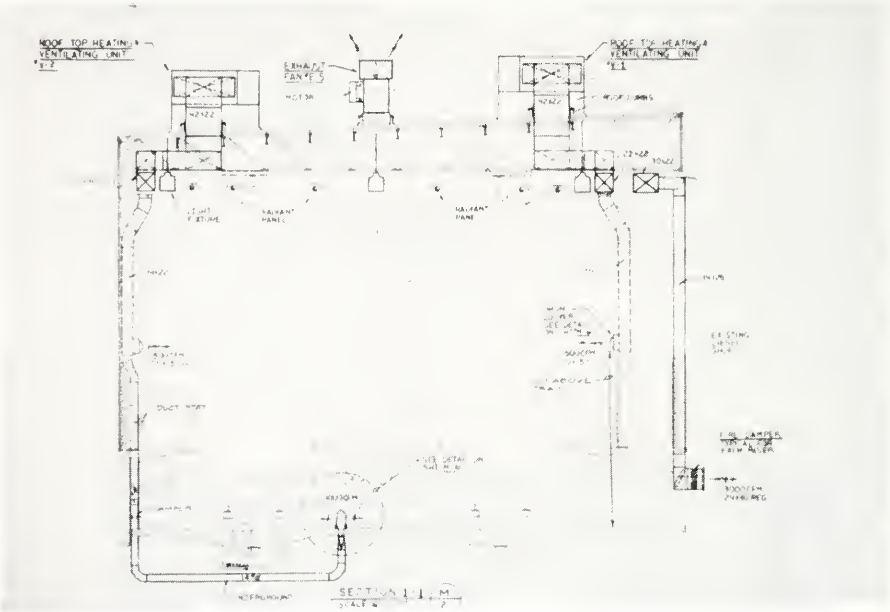
Additional Description

The new building is 355 feet long by 50 feet wide with an additional five feet of width for 234 feet where a common wall occurs between the old and new shop. Although the building's foot print is nearly 19,000 square feet, with its raised foreman's office, side and center cantilevered concrete platforms, total building usable space is nearly 30,000 square feet.

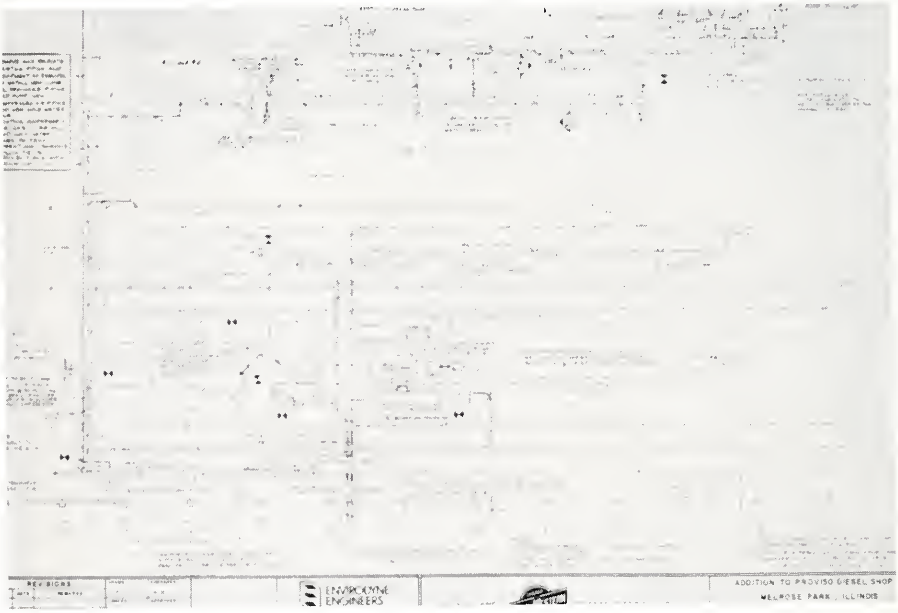
The building has two tracks spaced at 24 feet off center, each with continuous open side inspection pits capable of servicing eight locomotives simultaneously, four per track. The pit floor is four feet below top of rail, service floor is two feet nine inches below top of rail, and platform elevation is five feet three inches above top of rail. A special elbow adapter on the Snyder fuel nozzle places the platform high enough to allow fueling to take place below, without obstructing access to lower cab side panels from the top side. (Standard freight locomotive platform heights are four feet nine inches above the top of the rail.) The top of rail to underside of truss is 32 feet, to the lowest ceiling point 35 feet two inches and to the highest ceiling point 37 feet six inches. A small toilet room is located on the north side platform at the west end, and a raised foreman's office at eight feet two inches above top of rail is located between the two tracks at the west end of the building.

Inspection pits are built on a two feet by eight feet track slab with a continuous trench drain. Open sides are created by utilizing eight-inch by twelve-inch structural tube support columns capped with a nine-inch long horizontal section of the same eight-inch by twelve-inch structural tube with a center one foot three inches long by five-eighths inch thick stiffener plate through it. This horizontal section of tube provides an out of the way location for running required pipelines, and the extra long stiffener plate provides an area for anchoring pipe.

After 19 and 20 mains were shifted during the summer of 1987, the 66-inch corrugated metal culvert pipe was relocated and extended to this point by August, 1987. The building contractor's work then began with demolition of the six feet by six feet concrete box culvert. Simultaneously, the old wash rack and fueling station on the old run-around track were removed. Footing work and all underground utility construction ran through the month of November. Foundation walls were poured in late November and cantilevered side platform work began in December. The south platform utilized special diagonal braced formwork hung from foundation wall, while the north platform was shored. Efforts were concentrated on the side platforms so that the structural steel frame


ROOF TOP HEATING & VENTILATING UNIT V-2
EXHAUST FANS
ROOF TOP HEATING & VENTILATING UNIT V-1
SECTION 1-1 M

Cross section showing heating and ventilation systems.



Plan view of piping systems added to existing building.

and building shell could be completed before the snow began to fly.

Because the structural cantilevered slab design required continuous longitudinal reinforcing bars for its entire length, expansion and contraction joints could not be provided in the slab.

In addition, because time was critical, and the dead of winter fast approaching, we wanted to keep the time between adjacent pours to the minimum tolerable. Our goal was to minimize shrinkage cracks by using a low water cement ratio, .4, and keep fines in the concrete to a minimum. To ensure concrete workability under such conditions, we used superplasticizers in the concrete. The superplasticizer changed the original two and one-half inch slump concrete to eight inches. Intervals between adjacent slab pours were between five and seven days.

After the side platforms were completed, the structural steel frame was set during the month of January. While metal deck work was in progress, workmen also began installing interior metal liner panels, followed by a semi-rigid fiberglass insulation core, and the finished exterior panel.

Miscellaneous details shown here indicate seven feet four inches high concrete block protection wall and expando flash joint between old and new construction. Anchor studs were drilled into existing stone coping to facilitate wood nailer installation followed by expando flash, metal counterflashing, and metal coping cap.

After the metal deck went down, all roof accessories were secured in place: bases for flue stacks and vent pipes for the Co-Ray-Vac infrared heating system, roof top unit support curbs, duct openings, pipe supports, exhaust fan curbs, and sand tower curbs.

When weather improved, a urethane foam and peralite composition insulation board was applied followed by Tampko Awaplan base sheet and a single layer of Tampko modified asphalt, mineral surfaced roofing. A second layer of light colored roofing material was also mopped down to act as an equipment service walkway. The roofing system is guaranteed for 12 years and is an identical match to the reroof system used on the existing building approximately five years ago.

Once building siding was installed in February, overhead door openings were closed off with visqueen curtains, and a large portable gas-fired furnace was brought in by the contractor to thaw out the subgrade in the center of the building. It was well over a week and with a little help from Mother Nature, before the subgrade had thawed and was again suitable to work.

Before we go much farther, let's look at the mechanical requirements for the project.

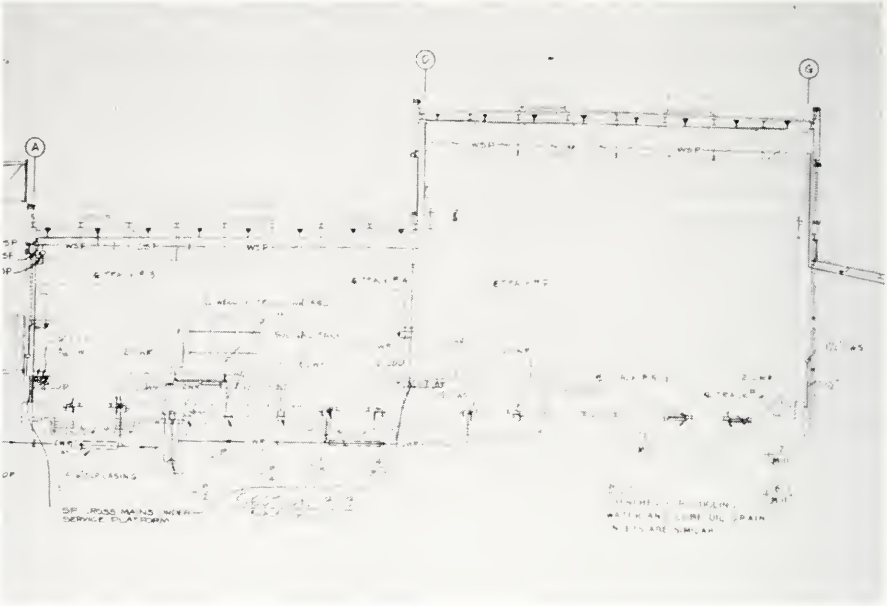
Industrial waste line was relocated and replaced by a new 18 inch line which looped south around the new building. All laterals from existing building and new stubs from inspection pits were all installed simultaneously with building footings. Remainder of underground pipe work: sanitary, cooling water supply and return, journal oil supply and return, fuel oil, compressed air and lube oil feeds all had to be installed before track slabs and service floor concrete could be poured. In addition to piping, eight 14-inch diameter P.V.C. coated spiral duct runs had to be installed before track slabs could be poured.

Heating and Ventilation Cross Section

The building's primary heating method is via a gas-fired infrared heating system, since the building will constantly be exposed to heat loss by operation of overhead doors at the ends. It makes more sense to heat the objects within the space rather than attempting to heat the air. Radiant tubes will heat the concrete slabs below and they, in turn, will radiate heat back up, thereby increasing the building's comfort level. Roof top heating-ventilation units are sources for heated make up air. Since locomotives do not run inside the shop, the code required ventilation is only one cubic foot per minute per square foot of work area or roughly 2.5 air changes per hour. The system installed is designed to provide six air changes per hour. If all units are running, roughly 80,000 CPM.

Comparing this to the 32,000 CPM required dilution ventilation rate for one locomotive at idle speed in addition to 15,000 CPM of air required for the diesel combustion, a total of 47,000 CPM per locomotive would be required just to break even. With eight locomotives, this is 376,000 CPM, nearly five times larger than the system we are providing.

Drum louvers provide heated air to the plat-



Cross section of existing building piping systems.

Schematic for cooling water system.

form level.

In addition to the eight air drops down into the lower level of the new building, two of the roof top ventilation units also supply heated air to the lower level of the old building at ten separate locations.

The duct drops through the platform, runs through the common wall and is equipped with operable fire dampers. This is one of four directional blower-equipped 300,000 BTU gas-fired unit heaters provided at each rail door to help minimize heat loss when doors are opened.

A great deal of underground piping and duct work had to go in before track and slab work could begin. Once all the underground was installed, track slabs were poured. After the track slabs were poured, rail pedestals were set.

While track slab work continued from east to west, a conveyer was brought in to distribute crushed stone for subgrade of sides and center service floors.

Working from east to west again, after side service floors were poured, center platform support columns were poured. Then the fuel line pipe trench was boxed out, and the center service floor poured. Center service floor concrete was pumped into position, and 80 percent of it poured in one day.

Four side "duck-under" access points were also provided on each track, two on each side.

While track slab work was going on at the east end of the building, masonry and duct work was preceding it to the west, and simultaneously continuing.

Inspection pit end access stairs and approach slabs were worked in together with center platform pours.

While all that activity was taking place in the addition next door, there was still quite a bit of work to be done in the existing shop.

Three sanitary dump stations were being installed, one on the south side of track three, one in between tracks three and four, and one on the north side of track four.

Lube oil drain lines were being installed along tracks three, four and five. These lines are heat traced and insulated and flow by gravity to a suction accumulator tank located below the service floor elevation in an existing pipe tunnel. From there, lube oil is pumped outside into an existing dirty lube oil storage bunker. A locomotive radiator coolant water draining and recycling system was also built on the lower level between tracks three and four and it serves tracks one and two in the new building in addition to tracks three, four and five in the existing building.

At its worst, the lower level between tracks three and four looked like this. However, we worked very closely with our motive power department and kept them in service through most of the activity.

The bulk of the existing building work involved construction of the cooling water system.

Simply speaking, the system contains two 1500 gallon tanks. Cooling water drains into one and is batched into the other utilizing a one-half horsepower transfer pump from the drain tank to recycle coolant, fresh water to dilute coolant, and from the one-quarter horsepower chemical feed pump to strengthen coolant's concentration of boron nitrate.

This isometric depicts the exact system. All lines drain by gravity to the sump basin. Floats in the sump basin automatically pump used coolant into the drain tank. A high level alarm sounds if the drain tank gets too high. The transfer pump is manually operated. The coolant supply pump runs off of a pressure switch located on a Weltrol pressure tank.

The supply pump is also protected by a low water float located in the fill tank. Each tank is equipped with a 12-kilowatt immersion heater. Both tanks and all supply lines are insulated thereby allowing the system to provide and maintain 100 degree water.

In the new building, pipelines are nicely tucked away under the base of rail because of the horizontal tube sections we discussed earlier. But in the old building, pipelines sit adjacent to rail directly on top of the inspection pit wall. Falling dirt, oil, sand and large objects would destroy pipe insulation and create a crevice requiring regular maintenance. To avoid all that, CNW built 12 gauge sheet metal shrouds to deflect all debris and protect pipes. Shrouds are built in sections which are easily dismantled by removing a few screws.

Let's go back and see how the new building has progressed. The lower level contains four pairs of hose reels, one at each locomotive spot. Each reel is fed from an accessible six inch fuel line located in the pipe trench shown. Reels are spaced to allow pallet mover traffic to get by. Each reel is equipped with electric rewind, a nozzle holster mounted to the nearest column, and start, stop, and emergency stop push button pump controls. Every other column is also equipped with regulated quick connect air drops.

Air, cooling water drains, and journal oil supply and return lines are provided along either rail on each track. The device up along the ball of rail is the motive power department's train control test loop. The orange tent shaped device is a ventilation system air supply register.

Each locomotive spot has a journal oil hose reel on either side of the track and a sanitary dump station. Also note the journal oil hose reel on the left and a domestic water reel for sanitary hose down on the right.

The interior of each inspection pit is equipped with journal oil dispensing hoses supported by a festoon system. Removable center trench grating is of fire retardent fiberglass.

The under-platform sodium vapor lighting system utilizes a modified version of a standard wall pak fixture which makes it totally drip proof when mounted in the horizontal position (wall paks are meant to be vertically mounted). These fixtures are low profile, and punch light out into the under carriage of the locomotive making it ideal for inspection purposes.

The shop has its own electrical switch gear and a small toilet room. Writing shelves for filling out inspection reports are also provided on each platform.

Directly in front of the foreman's office at the far west end and mounted to the mast of sand tower No. 1 is a special control panel. It contains start and stop buttons for each exhaust fan and all roof-top heated make-up air ventilation units. A single emergency stop button stops all systems. An emergency stop button for the fuel system is also located there.

On the lower right hand corner, there is a different audible alarm which notifies everyone that locomotives are about to move on a particular track.

The east end of the building contains an extra long approach slab to facilitate material handling. Two two-ton hoists operate off a monorail to lift pallets onto a center platform and facilitate minor emergency locomotive repairs. Note the 12 feet high overhead door which leads to a material handling access road running east of the existing building and the special unit heater over each track door. They are interlocked with the door operators.

Up on the platform level we have five separate hose reel support stands equally spaced to give full coverage to the entire length of the shop. Each stand includes one three-fourths inch quick connect air line, one one-half inch fire hose (used for housekeeping purposes), one one-half inch lube oil line, and one one-half inch engine cooling water supply.

The ceiling area contains the Co-Ray-Vac infrared heating system, gas lines and vent lines serving it, duct work, sprinkler system, high bay type high pressure sodium light fixtures, and condensate drain lines from the Co-Ray-Vac tubes.

The sprinkler risers for both existing and new buildings are on the north common wall. Dry systems cover the first 60 feet of the extreme east and west ends of each building, and a wet system covers the middle areas. The system has various zones with flow switches and supervised valves which run to an alarm panel in the foreman's office and is tied to the Melrose Park Fire Department by telephone lines.

Five sand tower masts penetrate the center platform and roof at 66 feet centers. The three interior towers have four spouts each, and the extreme end towers have two spouts each. When not in use, spouts are in the full up position and tied off to the side. Each spout has a rope for proper positioning before lowering.

A remote push-button control is mounted near the bottom of each rope to adjust the sand nozzle height depending upon size and type of locomotive. It allows the mechanic to adjust height either from the side platform or from the top of the locomotive. When sanding is completed, hoses are returned to their tied-off position. A local-push button is also located on each sand tower mast on the center platform.

Spouts are made operational by an air cylinder and two four-way solenoid valves which modulate air pressure to each end of the cylinder. Sand flows down into the spout by gravity from 50 cubic feet capacity sand bins located on the roof. An emergency shut-off valve for each spout is located on the catwalk of each tower. Sand is conveyed to each tower by a patented dense phase pneumatic system in which the sand lines are always full of product.

It is all made possible by the addition of an air booster fitting located along the conveying line that shoots air into the line, just ahead of a slug of air which is already pushing the product through the line. The booster agitates sand already in the line, thereby reducing the friction the slug of air and sand needs to overcome. An air control module sequences the air flow so that the booster's shot of air only comes just ahead of the slug of air which is actually doing the conveying.

Although higher operating pressures are generally used with this type of system, because the air is only used in short pulses rather than continual surges, the dense phase system actually uses a very low amount of air in relation to the amount of product being conveyed. This is also important, because it greatly reduces wear and tear on inner walls of conveying pipe and fittings.

Conveying sand to the five towers up on the roof requires four pipe lines: a three inch sand conveying line; two inch booster air line; one one-half inch air supply line, and a one inch electrical conduit for control and power wiring to operate solenoid control valves for booster air and block valve limit switches which really act as proving circuits that verify that the air actuated valve is in the proper position to convey.

The sanding system has its own 585 cfm, 125 horsepower air compressor supplying 120 psi air and is housed in a building adjacent to the sand storage silo. A pressure tank and regenerative air dryers are also housed here.

A network of concrete pipe trenches was built to get the sand from the unloading area to the storage silo and, in turn, to the various points of use. Sand is unloaded by a device called a SuperMax. It vacuums sand out of hopper cars and blows it up into the sand storage silo via connection to one of these angled pipes.

Twelve stations identical to this were provided to allow SuperMax to move back and forth between hopper cars thereby eliminating the need to respot cars over a single unloading device. Once sand is in the silo, a transporter located in the bottom of the silo conveys sand to the point of use.

The air control module that activates air pulses and modulates booster air pressure is also located at the bottom of the silo. An extra sand tank and hose drops from the silo were added to give the motive power department extra flexibility when sanding switch and yard engines. An additional two-stanchion outside fueling facility was added for this same purpose.

On the outbound side of both the new and existing shops, locomotive jump start stations were provided. A jib crane, which in its normal clear position is parallel to the tracks, supports the jumper cables. When needed they are swung perpendicular to the track. Note that jib boom lengths vary depending upon the track centers they serve.

These direct current power jump start stations utilizing deep cycle power rectifiers, originally designed for the steel plating industry, are a new innovation for railroad use. The units use standard 480 volt alternating current power and while providing as much as 2,000 cranking amperes, can start a totally dead locomotive, even with the batteries disconnected. Jumper cables are pulled through the locomotive window from the jib boom and connected directly to the direct current bus. A CNW-designed safety interlock guards against the danger of reverse polarity.

Besides the building work, 19 and 20 main and an electrical pole line were shifted south adjacent to the east five yard office. New lead tracks and a locomotive marshaling yard were also built. A wash rack was built on the main lead into the new building. It has a two-inch soap/water wash hoop and a three inch rinse hoop which applies 140 gallons per minute of water at nearly 400 PSI. The hoops are spaced 130 feet apart and are controlled by signal track circuits.

The system is activated from the cab of the locomotive eliminating the need to operate the valves and pumps. A standard hand-held garage door opener transmitter activates the system, while relays from track circuits sense when the locomotive is under the wash and rinse hoops. The garage door transmitter and receiver were made necessary because the track is used for engine moves other than washing.

Total project costs:

66-inch culvert work	$ 250,000
Track work	1,500,000
Building contract	4,250,000
Grand total	$6,000,000

The above did not include engineering costs.

On behalf of the Chicago and North Western, I would like to thank you for the opportunity of sharing this project with you. (Applause)

Mr. Burns: Thank you, Paul. As previously announced, instead of the scheduled presentation on controlled demolition of bridges, the next special feature is on roller compacted concrete and will be presented by Mr. Brian Bock of the Portland Cement Association. Mr. Bock received a Bachelor of Science degree in civil engineering from the University of Illinois, Champagin-Urbana, in 1982. After graduation, he spent four years with the New York State Department of Transportation, Rochester Region, working in the areas of design and construction. For the past two years, he has held the position of paving engineer with the Portland Cement Association's general office in Skokie, Illinois.

Mr. Bock is a member of the American Society of Civil Engineers, the Transportation Research Board, the New York State Association of Transportation Engineers, and the American Society for Testing and Materials. He is registered in New York State as an intern engineer and in Illinois as an engineer-in-training. May I now present Mr. Brian Bock.

ROLLER COMPACTED CONCRETE

Brian T. Bock

Paving Engineer
Portland Cement Association

Roller-compacted concrete is a relatively new material that has found a ready market in industrial pavements such as intermodal yards, truck parking areas, and log-sorting yards. It is ideal for pavements carrying heavy vehicles but having low-to-medium traffic speeds.

Roller-compacted concrete, or RCC, is a dry, no-slump concrete. It looks like damp, gray gravel. RCC differs from its cousins — soil cement and conventional concrete — but borrows traits from both materials. RCC's cement content approaches that of conventional concrete, but less water is used in the mix. Strengths match, or even surpass, those of conventional concrete.

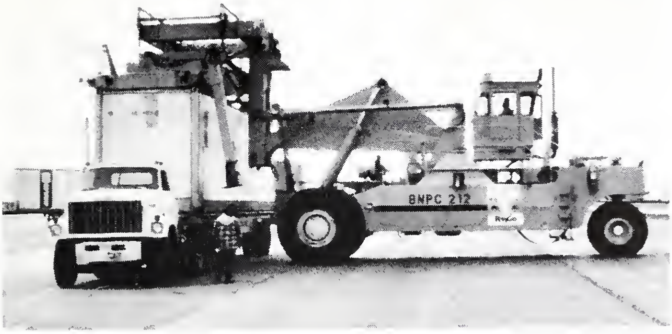
Unlike conventional concrete, RCC is rolled rather than cast. RCC construction methods are similar to those for soil cement pavements. Typically, the mix is placed with modified asphalt paving machines, then compacted with rollers to proper density. Yet RCC has higher cement content and greater strength than soil cement. It functions as a true concrete pavement requiring no additional surfacing. Soil cement, however, is used as a base course on which an asphalt wearing surface is placed.

RCC has its roots in dam construction. As a substitute for earth or gravel embankment dams, RCC is placed in layers to form the dam. Less material and labor are required because of RCC's higher strength. The resulting dam is both stronger and more economical to build.

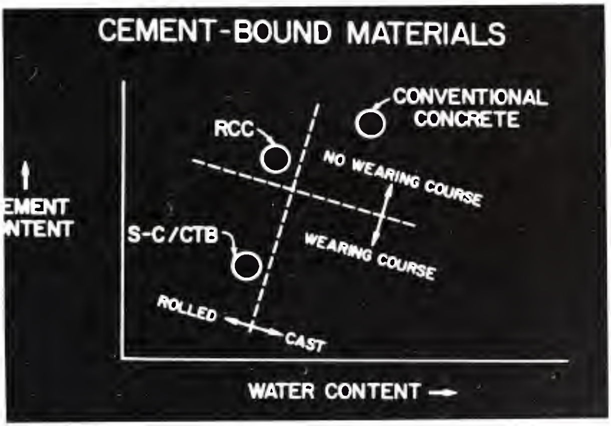
Beginning in the 1970s, RCC was used to pave logging roads and log-sorting yards in Canada. Since then, its use has expanded to a variety of heavy-duty pavement applications. Although RCC used for pavements differs from RCC used for dams, it retains the same basic virtues: strength and economy. RCC pavement costs about one-third less than conventional concrete and about 10 percent less than asphalt pavements.

RCC's economy stems from reduced labor costs and high-volume production. Unlike conventional concrete, RCC needs no finishing and texturing. There are no joints to cut, seal, or maintain. RCC is placed with commonly available equipment: asphalt pavers, vibratory rollers, and pneumatic-tired rollers.

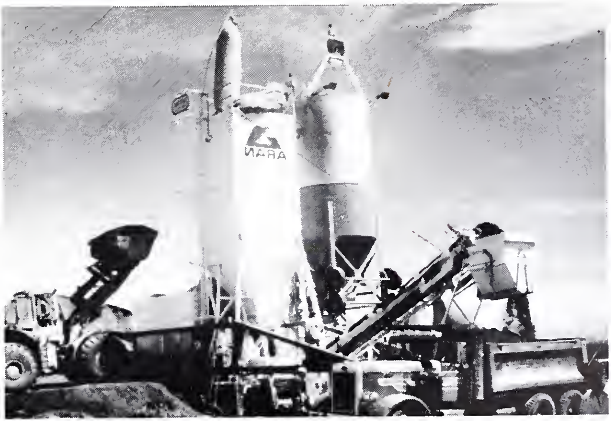
RCC's high strength makes it competitive with asphalt. In equivalent designs, RCC pavement can be much thinner than asphalt pavement. That means less material, less labor and less cost. A recent example is an aircraft parking apron at the Portland, Oregon, International Airport. The asphalt design resulted in a pavement section that was 36 inches thick: 19 inches of subbase, four inches of aggregate base, eight inches of asphalt base course, and five inches of asphalt surface course.



RCC's low cost and high strength make it ideal for industrial pavements such as intermodal yards, truck parking areas or log-sorting yards.



On the spectrum of cement-based materials, RCC is between soil cement and conventional concrete.



RCC is produced on site with a continuous-mixing, twin-shaft pug mill.

The equivalent RCC section consisted of 14 inches of RCC on a four inch aggregate base. The lowest RCC bid was 32 percent less than the lowest asphalt bid and RCC got the job. As in conventional concrete pavement, the strength is in the RCC pavement itself. The subbase and base courses required in an asphalt design are many times unnecessary in an RCC design. Often, RCC is placed directly on the prepared existing subgrade.

RCC is proportioned and mixed at or near the construction site. Mixing RCC requires strict quality control because it is such a dry mix. Most U. S. projects have used a continuous-mixing, twin-shaft pug mill set up on site. This type of plant can produce 250 to 500 tons per hour of RCC. Mixing time is about 30 seconds. A belt carries the mix to a discharge hopper to provide limited storage between loads. Dump gates allow rapid discharge of the mix without segregation.

Dump trucks transport the material to an asphalt paver. Many projects specify a paver equipped with a dual tamping bar, which consolidates the material to about 95 percent density. Achieving this density right out of the paver leaves less compacting for the rollers. There is less chance of movement under the rollers, the grade is easier to maintain, and the finished pavement is smoother.

Often, two machines will pave adjacent lanes in tandem. This practice minimizes longitudinal cold joints between lanes in the pavement. Pavement more than 10 inches thick requires multilift construction of RCC. To ensure a good bond between the layers, contractors place the second lift within an hour of placing the first lift. The mix is stiff and dense enough to support a second paving train placing RCC on the first lift. If more than one hour elapses between lifts, an acceptable method of bonding is to place a thin layer of cement-sand grout between the two lifts.

Once the material is placed, compaction follows immediately. Most contractors use vibratory steel-wheeled rollers for initial compaction. Subsequent compaction with pneumatic-tired rollers smoothes the pavement and closes up the surface.

On most projects, the number of roller passes and the pattern of rolling are determined on test sections before the job starts. The test sections also help to acquaint workers with the material and how it reacts to rolling. Compaction is checked with a nuclear density gauge to ensure the pavement reaches 98 percent density.

Control joints are not used in RCC pavement. On early jobs, sawing joints tended to spall the edge. Current practice is to let the pavement crack randomly. Because the mix is so dry, the transverse shrinkage cracks are minimal, occurring anywhere from 40 to 100 feet. The cracks do not open up excessively, and aggregate interlock is maintained across the faces of the crack. The surface appearance of the completed RCC pavement is similar to gray asphalt pavement.

The final construction step is curing. Depending on the availability of water, specifications for curing RCC are usually the same as for curing conventional concrete—seven days. And as with conventional concrete, curing is essential for achieving strength and durability.

The most common methods of curing RCC are water trucks or a sprinkler system. Curing compounds are not as effective because of RCC's open texture. At least two applications of curing compound are required to seal the surface.

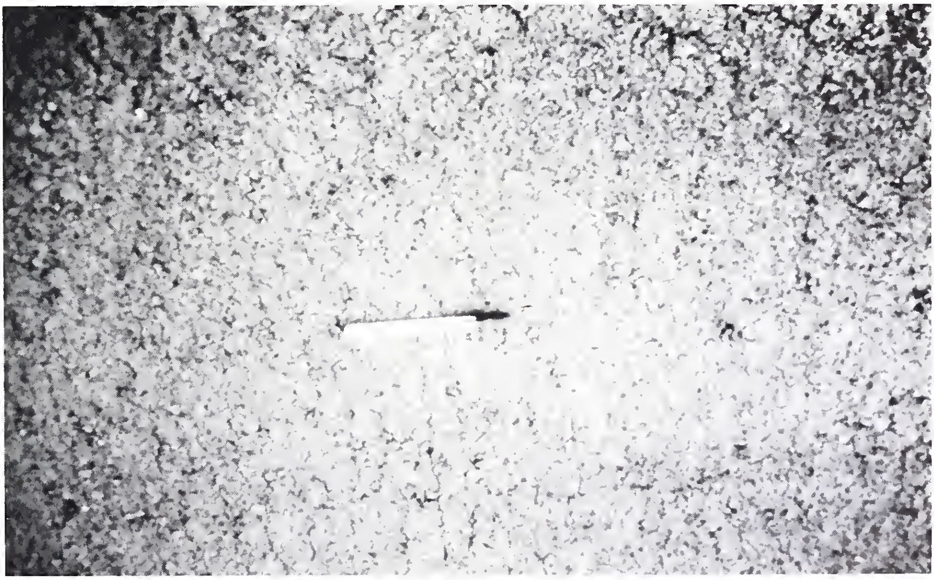
As with any relatively new material, questions remain concerning RCC mix design, construction methods, and quality control measures. As we gain more experience with the material, these concerns will be addressed.

Research will answer some of these concerns. Groups such as ASTM, ACI, Corps of Engineers and PCA are working toward standardized quality assurance and testing procedures. Right now we borrow standard procedures from established materials such as soil cement and conventional concrete.

Other areas under investigation are freeze/thaw durability and long-term performance. Conventional concrete achieves freeze/thaw durability by air entrainment, but to date engineers and contractors have not entrained air on construction projects. Laboratory research and performance studies show mixed results: some RCC is durable under freeze/thaw conditions and some is not.

Research by the PCA and Corps of Engineers is addressing freeze/thaw durability and air entrainment. Laboratory studies are under way to test RCC's ability to withstand repeated cycles of freezing and thawing. The Corp of Engineers will conduct field studies at a project now under

Curing RCC is essential for achieving strength and durability. Here, the pavement is kept moist with a sprinkler system.



The completed RCC surface resembles gray-colored asphalt.

RCC is placed with a modified asphalt paver, then compacted to 98% density.

construction; 420,000 square yards of RCC pavement at Fort Drum in upstate New York. The Corps hopes to air entrain some of the RCC for long-term durability tests.

Construction Technology Laboratories, a subsidiary of PCA, has researched RCC's engineering properties and thickness designs. The result of this research is design charts for single and dual wheel loads. For other wheel configurations, such as straddle carriers or twin tandems, a PCA computer program is available to calculate pavement thickness.

RCC is proving to be viable paving material for many industrial applications. Ideal candidates include airports, truck terminals, and material storage and handling yards. As researchers, designers, and contractors gain experience with RCC, its application will expand greatly in the future.

Mr. Burns: Thank you, Brian. I will now turn the program over to Ken Koff who will introduce the next feature. Ken.

Mr. Koff: Thank you, Byron. Our next topic is one of considerable interest on vegetation control. We have with us Mr. Tom Sheahan who has system responsibility for vegetation on CSX. He is the general supervisor of vegetation control and is headquartered at Jacksonville, Florida. Tom, welcome to our conference.

VEGETATION MANAGEMENT:
The Cost of Brush Clearance

Thomas F. Sheahan

General Supervisor Vegetation Control
CSX Transportation Company

Good morning. I was assigned my topic some months ago, and I knew that if I were to attempt anything quite that broad, we would be here forever and a day. So with your permission I thought I would make it a little more specific than that, and talk on one of my pet peeves. I have been in vegetation control for some years, and it has always been a challenge to me to try to find the optimum way of combining chemical control of weeds, brush, or whatever, with mechanical control. And, as you might surmise, that is a topic in which research goes on all the time. In particular, though, I would like to concentrate on brush clearance. You might wonder what differentiates a topic like brush clearance from pole line clearance or that type of thing.

Although the lion's share of the maintenance-of-way budget goes to rail, ties, and ballast, a surprisingly large portion of the average roadmaster's time is still spent in other miscellaneous pursuits. Not a small portion of his efforts may go to control vegetation by manual cutting, mowing, or mechanical on and off track cutting. As man hour allocations are reduced for basic forces, it is increasingly difficult to devote sufficient time to meet even minimum FRA standards for clearance and sight distances. It is more important than ever before to understand the relative costs and values of cutting versus spraying.

In 1986, the Chessie System component of CSX used a computer reporting system to record production statistics for its fleet of 12 on-track brush cutters. These totaled some 899.15 road miles cut in 1,049 machine days. They averaged 44 percent production time, 56 percent delay, of which 15 percent was mechanical repair, and the rest either train delay, crew travel, or other. The Seaboard System had nine machines which worked 963 days and cut 899.7 miles. For these there were no records kept of production and delay time. Taken together, they total some 1,800 miles in 2,012 machine days, or 0.89 cut road miles per day.

If one divides 0.89 miles per day by 3.52 hours production time per day, one finds an average speed of 0.25 or one-quarter mile per hour. Even assuming the average mile receives two passes, that is two swathes of the cutting heads (each six feet), the average must be only one-half mile an hour. This is far less than the two miles per hour manufacturers' specification speed used on the AFE on which the machines were bought. Why? Are the blades too dull? The engine in too poor repair? Are the trunks too wide, and density too great? Do the pilots change direction too often, or have to clear the track too often? Or are the records incorrect or misleading? One possible discrepancy is that double track takes twice as long to cut as single. However, most demand and use is on single-track branch lines.

Regardless of the speed of operation, the annual cost per machine in 1986 is given in Appendix A. The amortized cost per year plus maintenance and fuel costs, plus labor costs total $820 per day. Dividing the miles per day by daily cost gives $921 per cut mile. Since each mile should have a 12 foot swathe each side, or 24 feet total, the machine should have cut 24 feet by 5,280 or three acres per mile for 335 miles. This was a cost of $250 per sprayed mile, and assuming an 80 percent kill rate, $322 per killed mile, or $86 per sprayed acre. If the cost of the railroad pilot is included it would add $4 per mile based on 33 miles per day production average.

By the way, this clearance program, applied by hi-rail truck was only a small part of the entire brush spray program, which included 1,630 miles of signal and communication pole line pattern as well as clearance pattern. Since these figures are not for equivalent work, I have omitted them from consideration.

Several conclusions seem warranted. First there is a considerable amount of money being spent on both mechanical and chemical brush control. The machine cost for 1986 should have been $1,650,000 alone. The total chemical budget was over $700,000.

Secondly, chemical control costs a railroad only 28 percent as much per mile, and may give more lasting results. Does this mean all cutting should be stopped and everything treated by herbicides? Certainly not. Physical removal is not only preferable in many areas, but mandatory as well. Many adjacent areas are environmentally sensitive such as homes, gardens, crops, and sources of drinking water. Concomitantly, many miles are inappropriate for on-track machine cutting due to the hazards of thrown rocks and debris.

It is important that railroad management, including those at the roadmaster level, scrutinize which areas are appropriate to each method. How best to provide significant track time, proper maintenance, and above all, proper coordination between cutting and spraying. Some suggestions are as follows:

1. Use on (or off) track machines on subdivisions with the greatest percent of pines, cedars and other coniferous species which will die when cut.
2. Use on-track machines on subdivisions with the least train traffic, thus affording the most track time. These are likely to be the most remote ones, thus allowing the least opportunity for damage due to thrown debris. Coincidentally, these are also the areas that develop the worst problems.
3. Do not use cutting and spraying within several months of each other, preferably not in the same year. Brush herbicides require months for the active ingredient(s) to reach and kill the roots, preventing regrowth. If they are cut too soon the chemical never reaches them. Also, if foliage-active herbicide is sprayed too soon after cutting, there will be insufficient foliage to absorb the chemical, rendering it useless. The optimum sequence is to spray the following year.

Lastly, these machines are not cheap to buy or operate. It behooves us to keep them in good repair with periodic refurbishing at equipment repair shops. The most common causes of mechanical down time, according to the CSX equipment repair departments have been:

1. Dirt in the systems caused by the continuous movement of the blades. Dry years, such as 1988, make for even worse conditions which clog engine filters, radiators and hydraulics.
2. Misuse leading to bent blades, guards or boom failure.
3. Worn workhead bearings.

Many of these problems can be alleviated by field inspection and immediate repair. It would make more sense to use other brush control methods if these machines cannot be kept in good repair and given adequate track time.

APPENDIX A

Per day cost of on-track cutting

1. 1986 purchase price $180,000 10 year life span $180,000/10=18,000/100 days per year	=$180/day
2. Annual maintenance cost $34,000/100 days	= 340/day
3. Annual fuel cost $6,000/100 days	= 60/day
4. Crew cost 2 men at $15/hour×8 hours	= 240/day
	$820/day
$820/.89 miles/day	=$924/mile

APPENDIX B

Per mile cost of brush spray

1. 1986 cost of ½ gallon "Arsenal" at $61.50 @ 3 acres/mile	=$813.50
2. Cost of application at $25/acre	= 75.00
	$258.50/mile
3. Cost of pilot $15/hour× 8=$120/day Average daily production 33 miles	=$4.00

Mr. Koff: Thank you, Tom, for that informative report on something we all have to deal with.

Our final presentation of the conference is the Peacekeeper Rail Garrison Project by Captain Ken Creighton of the United States Air Force. Please welcome Captain Creighton.

PEACEKEEPER RAIL GARRISON

UNCLASSIFIED

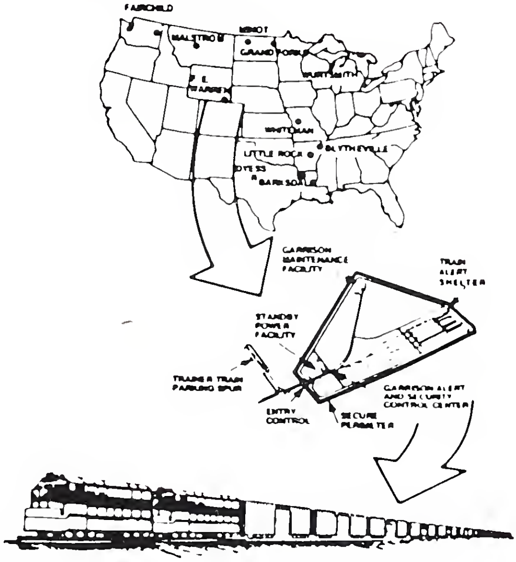
Captain Ken Creighton

United States Air Force
Norton Air Force Base

UNCLASSIFIED

PEACEKEEPER RAIL GARRISON
SYSTEM DESCRIPTION

- TWENTY-FIVE MISSILE TRAINS
    - TWO MISSILES PER TRAIN
- ELEVEN CANDIDATE BASES
    - MAIN OPERATING BASE: F E WARREN
- MISSILES ON STRATEGIC ALERT WITHIN GARRISONS
- DISPERSAL CAPABILITY
    - ON DIRECTION OF HIGHER AUTHORITY
    - SAFE MOVEMENT COORDINATED WITH RAILROADS



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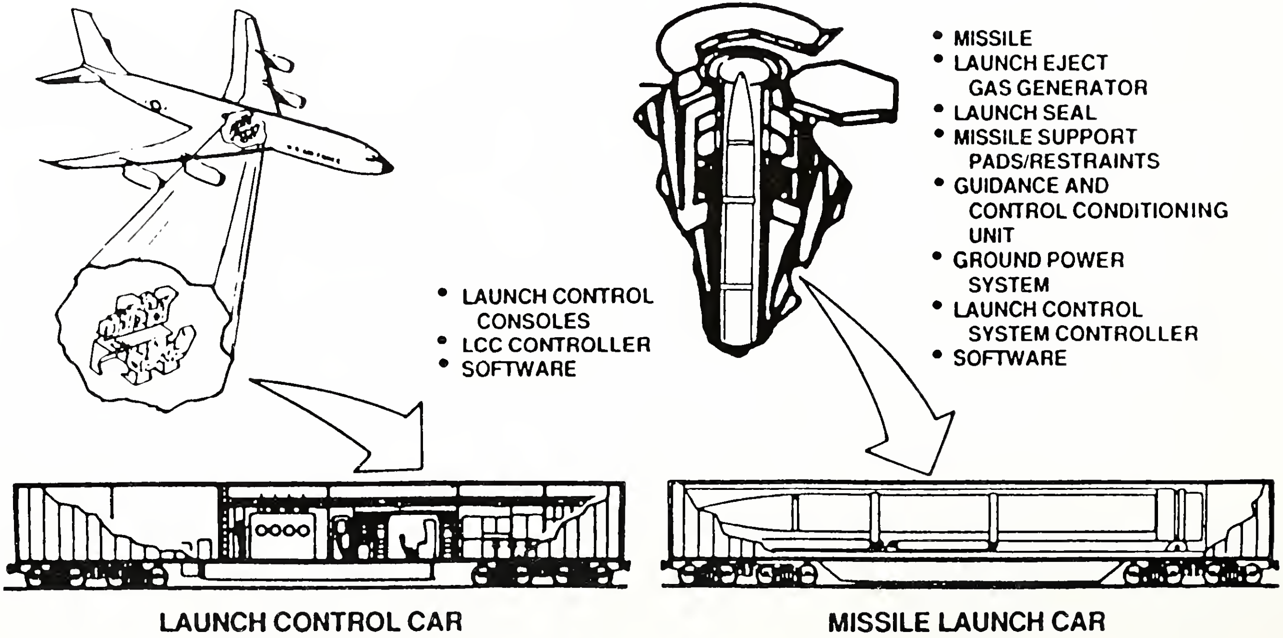
PEACEKEEPER RAIL GARRISON

SYSTEM DESCRIPTION
DEVELOPMENT APPROACH

- MAXIMUM USE OF EXISTING PEACEKEEPER AND LAUNCH CONTROL EQUIPMENT, TECHNOLOGY, PROCEDURES
- INTEGRATION OF RAILROAD EQUIPMENT AND PRACTICES



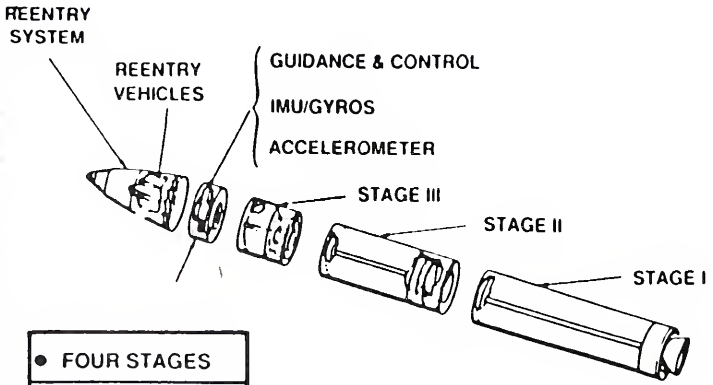
- LAUNCH CONTROL CONSOLES
- LCC CONTROLLER
- SOFTWARE

- MISSILE
- LAUNCH EJECT GAS GENERATOR
- LAUNCH SEAL
- MISSILE SUPPORT PADS/RESTRAINTS
- GUIDANCE AND CONTROL CONDITIONING UNIT
- GROUND POWER SYSTEM
- LAUNCH CONTROL SYSTEM CONTROLLER
- SOFTWARE

UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison
System Description
Missile



- FOUR STAGES
- 10 MK21 RVS
- 71 FT LONG
- 92 IN. DIAMETER
- 195,000 LB

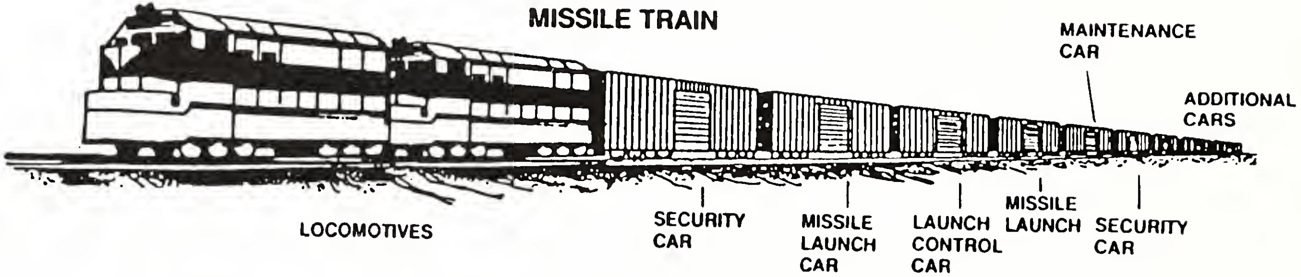
- PEACEKEEPER MISSILE
  - NO HARDWARE CHANGES
- SOFTWARE MODIFICATIONS
  - TARGETING
  - OPERATIONAL GROUND PROGRAM
  - OPERATIONAL FLIGHT PROGRAM

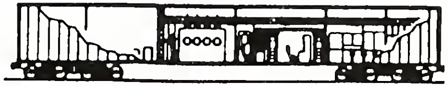
UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison System Description

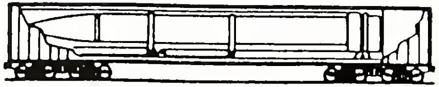
MISSILE TRAIN





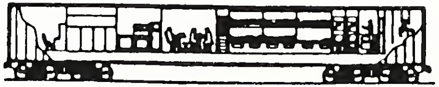
LAUNCH CONTROL CAR

- COMMAND AND CONTROL
- LAUNCH PROCESSING
- STATUS MONITORING



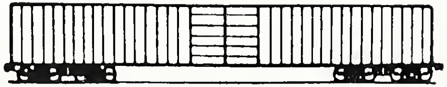
MISSILE LAUNCH CAR

- STABILIZATION CAPABILITY
- ERECTION MECHANISM
- LAUNCH PLATFORM



SECURITY CAR

- SECURITY FORCE/CONTROL



MAINTENANCE CAR

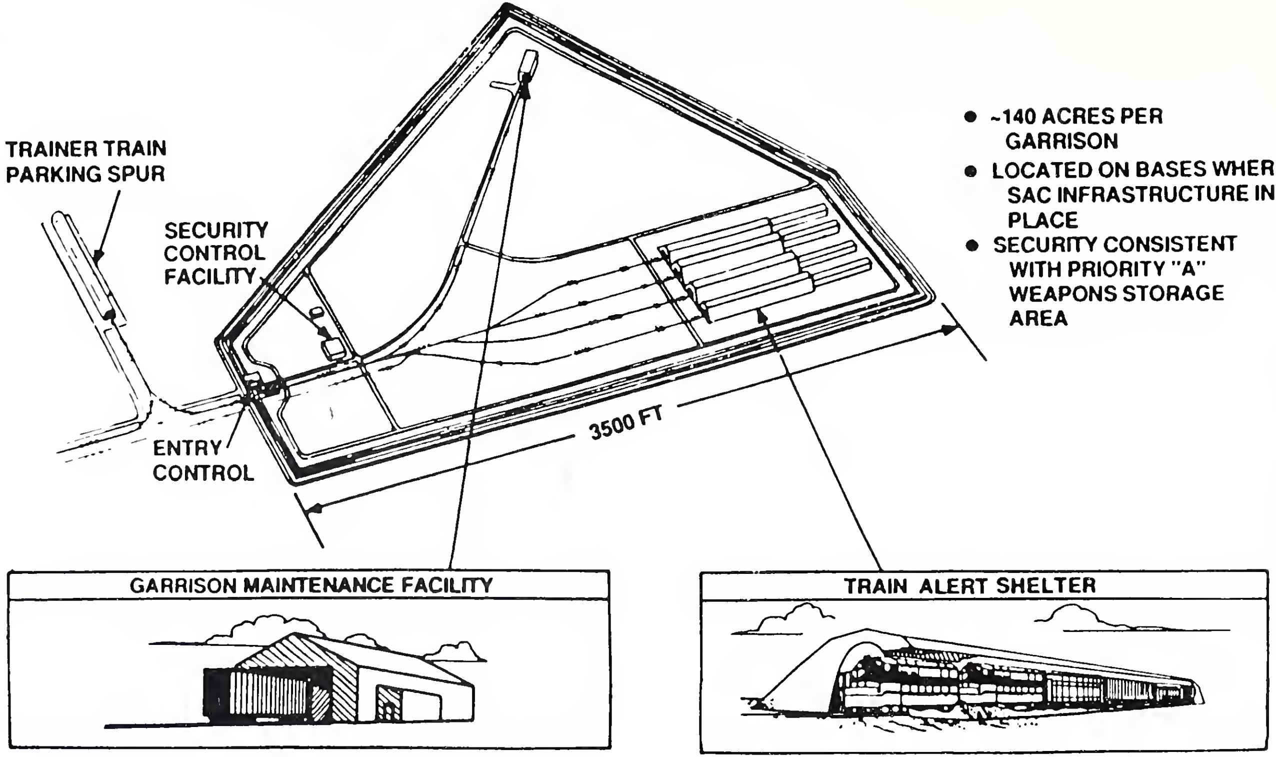
- SPARES STORAGE

UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison System Description

CONCEPTUAL GARRISON LAYOUT


TRAINER TRAIN PARKING SPUR
SECURITY CONTROL FACILITY
ENTRY CONTROL
3500 FT
GARRISON MAINTENANCE FACILITY
TRAIN ALERT SHELTER

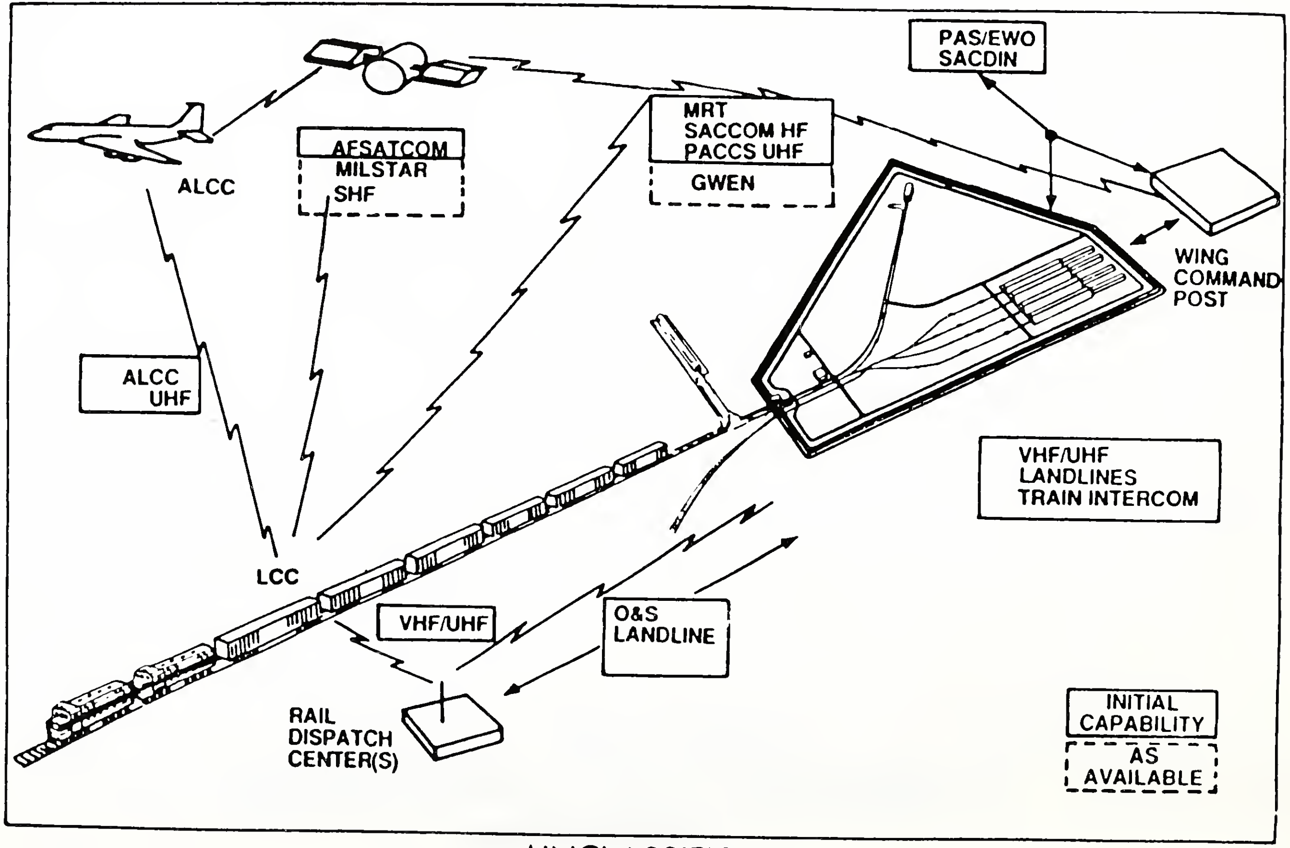
- ~140 ACRES PER GARRISON
- LOCATED ON BASES WHERE SAC INFRASTRUCTURE IN PLACE
- SECURITY CONSISTENT WITH PRIORITY "A" WEAPONS STORAGE AREA

UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison System Description

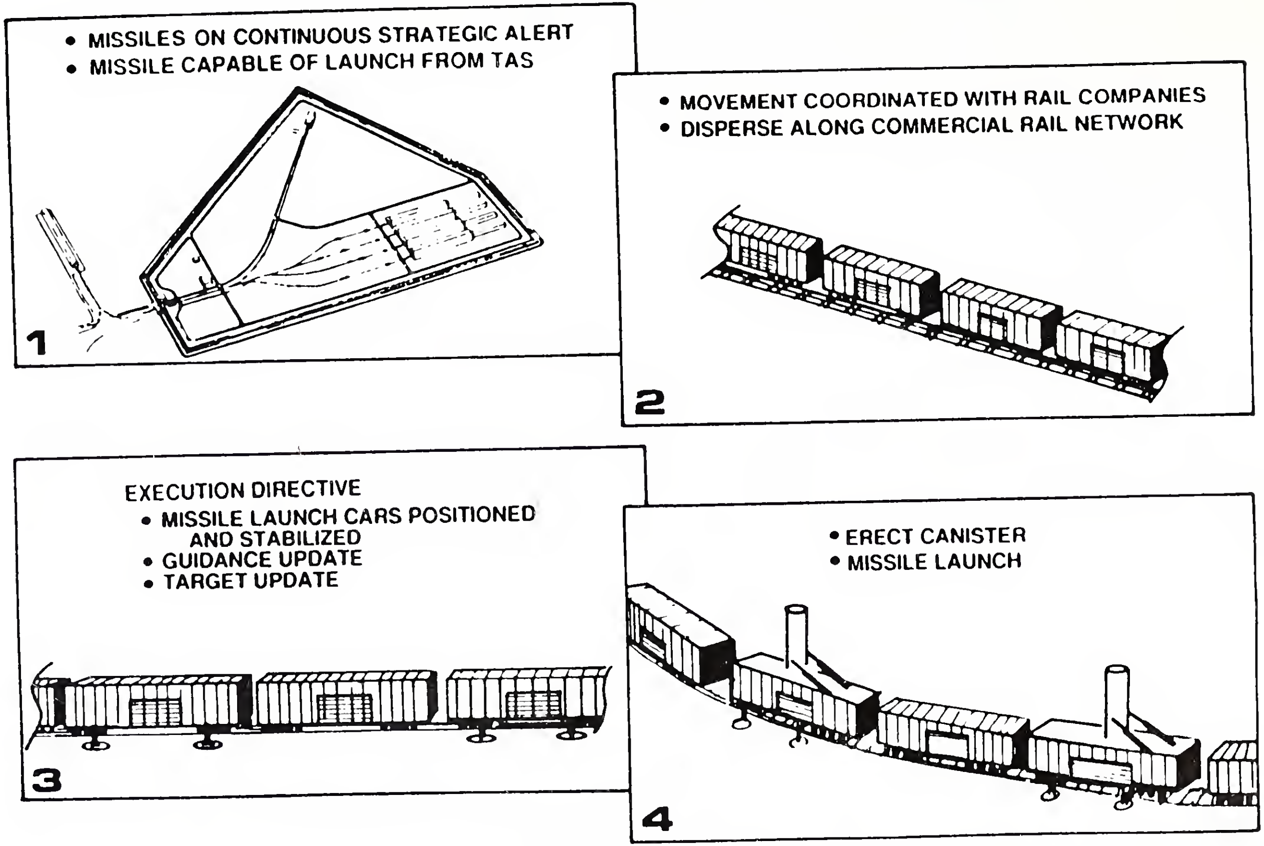
COMMUNICATIONS SYSTEM



UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison Operations Concept



- MISSILES ON CONTINUOUS STRATEGIC ALERT
- MISSILE CAPABLE OF LAUNCH FROM TAS

- MOVEMENT COORDINATED WITH RAIL COMPANIES
- DISPERSE ALONG COMMERCIAL RAIL NETWORK

EXECUTION DIRECTIVE
- MISSILE LAUNCH CARS POSITIONED AND STABILIZED
- GUIDANCE UPDATE
- TARGET UPDATE

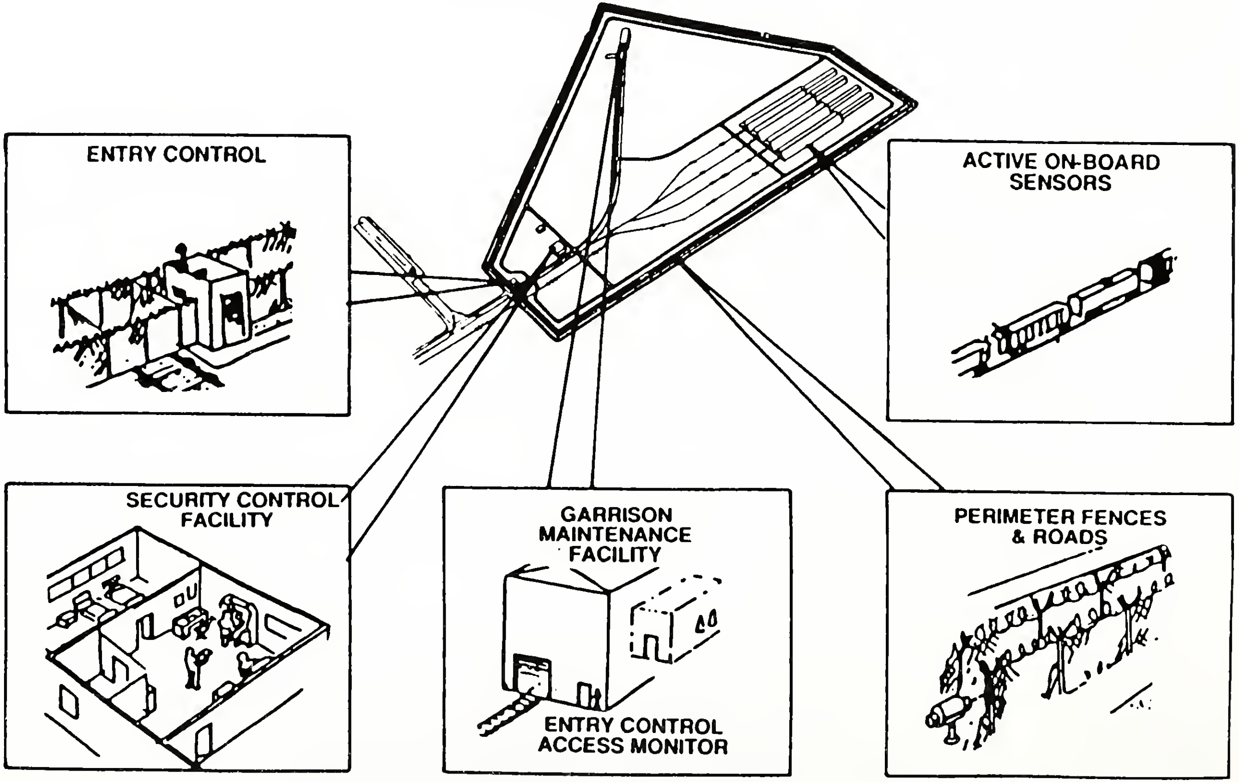
- ERECT CANISTER
- MISSILE LAUNCH

UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison System Description

IN-GARRISON SECURITY SYSTEM

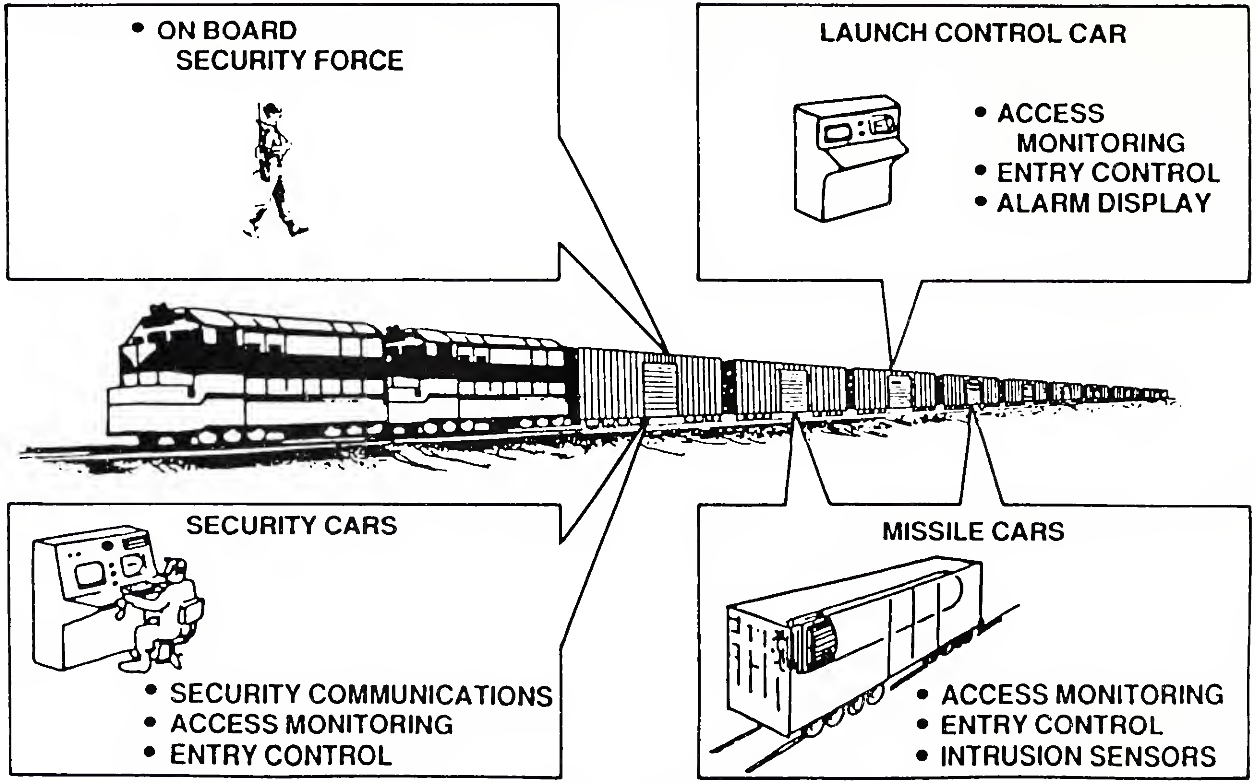

ENTRY CONTROL
ACTIVE ON-BOARD SENSORS
SECURITY CONTROL FACILITY
GARRISON MAINTENANCE FACILITY
ENTRY CONTROL ACCESS MONITOR
PERIMETER FENCES & ROADS

UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison System Description

DISPERSED SECURITY SYSTEM



- ON BOARD SECURITY FORCE

LAUNCH CONTROL CAR

- ACCESS MONITORING
- ENTRY CONTROL
- ALARM DISPLAY

SECURITY CARS

- SECURITY COMMUNICATIONS
- ACCESS MONITORING
- ENTRY CONTROL

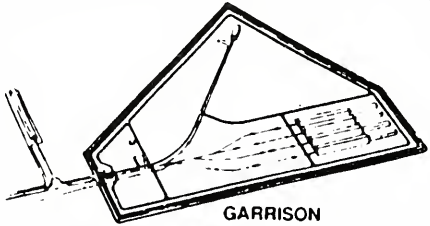
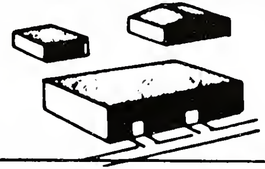
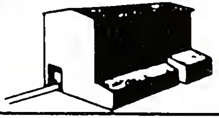
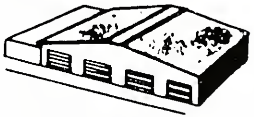
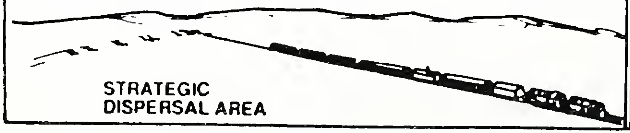
MISSILE CARS

- ACCESS MONITORING
- ENTRY CONTROL
- INTRUSION SENSORS

UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison Maintenance Concept

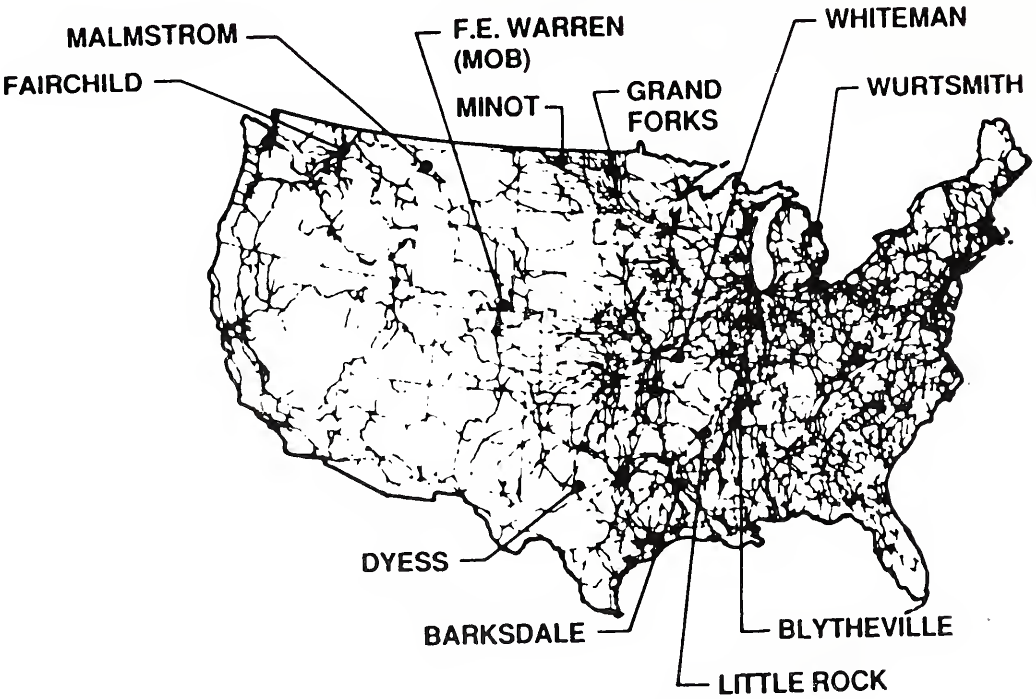
LOCATION		FUNCTIONS
 GARRISON	TRAIN ALERT SHELTER (TAS)	• ORGANIZATION LEVEL • MGCS R&R • OSE LRU R&R • MINOR TRAIN MAINTENANCE/SERVICING
	GARRISON MAINTENANCE FACILITY (GMF)	• ORGANIZATIONAL LEVEL • MGCS AND RS R&R • ROUTINE RECURRING MAINTENANCE (ECS/POWER) • TRAIN SERVICING
	GARRISON SUPPORT BASE	• INTERMEDIATE LEVEL • MECHANICAL SYSTEMS • PNEUDRAULICS • HYDRAULICS • ELECTRICAL/ELECTRONIC SYSTEMS LRU REPAIR
	F.E. WARREN (MOB)	• INTERMEDIATE LEVEL • MECHANICAL • ELECTRICAL • RS ASSEMBLY/MAINTENANCE DEPOT LEVEL • MISSILE/CANISTER BUILD-UP • MISSILE R&R
 DEPOT/TECHNOLOGY REPAIR CENTER (TRC)		• DEPOT LEVEL • MISSILE CANISTER MAINTENANCE • MISSILE STAGES AND GUIDANCE SYSTEM STORAGE/REPAIR • REENTRY VEHICLE REPAIR • REENTRY SYSTEM COMPONENT MAINTENANCE • OSE MAINTENANCE • OSE LRU/SRU REPAIR
 STRATEGIC DISPERSAL AREA		• ORGANIZATIONAL LEVEL • R&R HIGH FAILURE RATE LRUs • MGCS R&R

UNCLASSIFIED

UNCLASSIFIED

Peacekeeper Rail Garrison System Effectiveness

DISPERSAL CAPABILITY



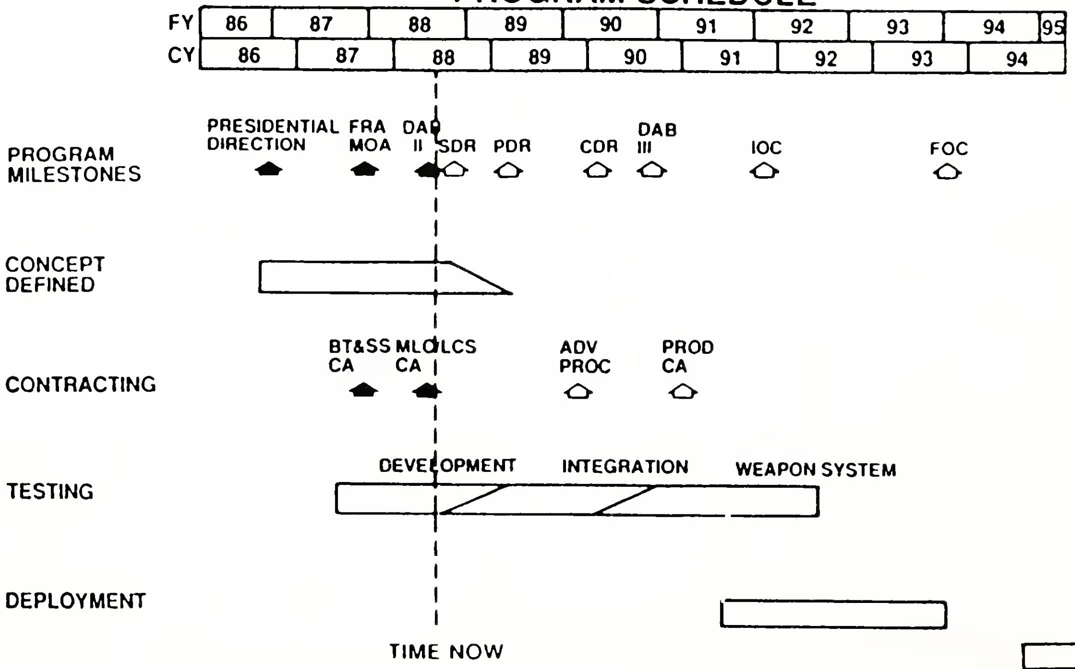
OVER 120,000 MILES AVAILABLE

UNCLASSIFIED

UNCLASSIFIED

PEACEKEEPER RAIL GARRISON

PROGRAM SCHEDULE



KEY	
FRA.	FEDERAL RR ADMIN
MOA:	MEMO OF AGREEMENT
DAB:	DEF ACQ BOARD
SDR:	SYS DESIGN REVIEW
PDR:	PRELIMINARY DESIGN REVIEW
CDR:	CRITICAL DESIGN REVIEW
IOC:	INITIAL OPS CAPABILITY
FOC:	FULL OPS CAPABILITY

UNCLASSIFIED

Member: I am sure you realize that five eight axle cars run by two passenger locomotives will stick out like a sore thumb. (Laughter)

Captain Creighton: That's true. Again, it is one of these directive requirements. We recognize that. We have done short train surveys, and I forget if it was the BN, UP or who, but we took 10 to 20 points on each line and literally, watched the trains go by, where we could see the routing information as it occurred. We recognize that what we have as a train does not fit what is out there on the commercial rail network. But again, it is one of those directive requirements and we are arguing about that now. Right now we are telling that initial directive that we will look at standard boxcars and diesel freight locomotives, but we are still challenging that. We haven't given up on that, hoping to convince people to give us some relief, because this hinders us a little bit with our design if we have to fall within a certain range. If it is a little bit shorter, little bit narrower, it really shouldn't matter to people, just as long as we don't go outside the plate constraints overall. But we are still arguing that, and we are following the direction we are going with boxcars even though I agree with you we don't look like anything that is out there.

Member: If the crew is going to be stuck for a week inside a boxcar with no windows you might have some people problems.

Captain Creighton: A lot of people problems if we go up to 40 people or more. We have them spread out among the cars, and the way it's viewed is that if it comes to that point to where there is a need for making accommodations for them on the train, they will have their own little private areas. We will try to make it as comfortable as possible. We are trying to get track information now on curves and grades, even to the point of wayside geometry, should we go to outriggers for stabilization from wind loading. We don't want to run into trees or vegetation, but we are out there collecting that information now.

The missile launch car that we are talking about weighs about 560,000 pounds right now. Our contract has an incentive clause, so if the contractor can reduce weight he gets more money. We recognize the weight problem, and we are trying to assess it but we don't want to go to the extreme of new material, composite materials, reinventing the wheel from the railroad point of view and coming up with new railroad designs. We would have to go through the long drawn out process of re-certifying or getting new designs certified. So we recognize the weight problem, and we are going after that with incentives on the contract.

This is our launch control car and the center section is cut away just to give you an indication that we are not putting in antennas all over the roof of our launch control car. We are dropping the roof and will put in a false roof, if you will, and our antennas will be there, and we will have radome covering on top, and that will look like a standard boxcar type covering. You won't be able to tell where the antennas are on the launch car, but there will be no exposed protrusions on our cars.

My principal interest lies is trying to work the agreements and understandings with the railroads on how we are going to operate a system on the commercial rail map and get the support and cooperation when needed with the rail industry. Everybody automatically jumps on that we have a nuclear asset rolling around on the commercial rails. Well that is the intent. We hope it won't come to that, and so I don't see that that has to be addressed, we have to work that out, and make sure it can happen should we need it. But you are going to have a lot of train traffic with our system based on the training trains. We have two training trains out there trying to keep missile crews proficient. You also have maintenance activity, where should there be a fault detected at the garrison on the missile, we have to pull that and get back to the depot or technology repair center. That will be by rails. You also have a test activity where you are going to be randomly pulling missiles out of the garrisons, and removing the re-entry stage at the garrison, and shipping that to F. E. Warren. So there is going to be a lot of commercial train activity on the network not directly involved with an operations dispersal. So I am in the process now of trying to work on a master operating plan that identifies all the various layers where there is potential for rail garrison activity on the commercial network. Identify what we expect to do, try to take a guess at what the railroads will do or not do, and go from there.

Member: Captain, do the Soviets have something along this line.

Captain Creighton: Yes.

Member: Have you scheduled any test flights?

Captain Creighton: We have currently scheduled five basic verification missile flights. If that is what you are talking about, operationally launching a missile from a car. We have five of those scheduled at Vandenburg Air Force Base. We are not going to go out on the commercial rail network and drive around, come back into Vandenburg and shoot. We are laying track at Vandenburg now to create a loop track, and we will drive around the loop track, go into our launch countdown sequence, and will launch from there. We have five of those built into our schedule. Each one does a little bit more as we go through them. The test program, that's like Peacekeeper now, had 20 flights scheduled; they are at 17 now. Each time you do a flight you add to it, and you do a little bit more. One will be with, say ground instrumentation, with a dedicated crew that has lived and breathed that missile. The next time you will do it with a full out missile combat crew and going through what the book says you should do. Another time you could do it with an air launch control center, so you are flying the plane and launch. So you do different things to the missile to launch it. Everything will be at Vandenburg. That is our test bed.

Member: How many contractors do you have?

Captain Creighton: Three contractors have been selected, Boeing for the locomotive and maintenance car; Westinghouse for the missile launch car, and Rockwell and Anaheim for the visible security and launch control car. Those are all five-year contracts, primarily to support the IOC and initial deployment of the training trains and the first train along with prototype hardware to support our testing. Boeing is responsible for taking the locomotive off the shelf, getting it wherever they get the locomotives from, responsible for doing those modifications for it and making sure it does what we want it to do. Any more questions? If not, thank you. (Applause)

President Lewis: Thank you, Captain Creighton. We appreciate your coming out to give us this presentation.

At this time I would like to call on Chuck Thompson, chairman of our Resolutions Committee. Chuck.

REPORT OF THE RESOLUTIONS COMMITTEE

Having reached the closing of the annual joint conference of the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America and being deeply indebted to all those members and friends who have contributed their time and efforts to make our conference a success, it is right that we should acknowledge this indebtedness, and that it shall be so entered into the minutes of this meeting.

Be it further resolved, that our deep appreciation be extended to those who have honored our associations with their presence and by their informative addresses:

H. J. Bruce, Chairman and Chief Operating Officer, Illinois Central Railroad
J. A. Zito, Senior Vice President Operations, Chicago and North Western Transportation Co.
S. J. McLaughlin, President, AREA
A. E. Shaw, Jr., Amtrak
Lars Lundberg, SRS-America
J. R. Beran, Union Pacific Railroad
Benjamin Allen, Iowa State University
V. C. Stensrud
D. B. Mabry, Railway Tie Association
R. S. Ohlis Jr., Koppers Company
D. C. Kelly, CSX Transportation
D. L. Smoot, Indiana Hi-Rail
Frank Brogdon, Cedrite Technologies
Ben F. Jezek, Victor Equipment Company
J. P. Raymond, Queens University

P. H. Saletnik, Chicago and North Western Transportation Company
Tom Sheahan, CSX Transportation
Brian T. Bock, Portland Cement Association
Captain Ken Creighton, U. S. Air Force
Anthony Lynn, Quikbridge
John Weber, New Jersey Transit Rail Operations
Roger Fitch, Union Pacific Railroad
Sid Blaauw, Paxton Vierling Steel
John Stubenvoll, Reach-All

and to all the committee chairmen and sponsors, who with the loyal cooperation of the committee members prepared the interesting and instructive reports that have been presented.

Be it further resolved that a very special thanks is expressed to Avon Lane, President of REMSA, and to all members of the Railway Engineering Maintenance Suppliers Association for the fine reception that we enjoyed last night. Our thanks are also expressed to Mrs. Nancy Jo Lewis and Mrs. Joan Snyder and their committee for their efforts in arranging registration and entertainment for our wives. Our thanks also to the management and staff of the Palmer House. We also thank the Santa Fe, Chicago and North Western and Illinois Central railroads who lent assistance to our registration desk during the conference. A special thanks goes to Pat Weissmann and Barbara Marlow. Without their unselfish assistance, these two Associations would have great difficulty functioning.

And be it finally resolved that both Associations express their heartfelt thanks to the outgoing presidents, Don Lewis and Ray Snyder, who have spent so much time and effort in guiding the activities of our two Associations with great efficiency and dedication during the past year.

I move these resolutions be adopted.

Respectfully submitted,

C. E. Thompson, Chairman
Resolutions Committee

President Lewis: Thank you, Chuck. I would like the immediate past president of the Bridge and Building Association, Mr. John Kapp, who will install the officers-elect of the American Railway Bridge and Building Association for 1988-1989, and Mr. Mike Marlow, immediate past president of the Roadmasters and Maintenance of Way Association, who will install next year's Roadmasters' officers, to come forward.

INSTALLATION OF OFFICERS

Mr. Kapp: Thank you, Don. The following is a list of officers-elect of the American Railway Bridge and Building Association for the administrative year, 1988-1989. The officers so named please step forward, and take a position on my left.

For President, Raymond A. Tallent, Jr., process engineer-structures, Norfolk Southern Corporation, Atlanta, Georgia; Senior Vice President, Byron T. Burns, assistant manager structures, Atchison, Topeka and Santa Fe Railway, Topeka, Kansas; Junior Vice President, John J. Horney, program engineer B&B, Union Pacific Railroad, Omaha, Nebraska; Junior Vice President Mark C. Walbrun, manager engineering design, Amtrak, Chicago, Illinois.

For Director for the terms ending 1991: Steve Lipkus, bridge and structural maintenance engineer, Canadian National Railways, Edmonton, Alberta, Canada; Michael L. Bradley, project engineer, Conrail, Columbus, Ohio; Thomas V. Dunn, bridge engineer, Chicago and North Western Transportation Company, Chicago, Illinois.

Treasurer, James M. Williams, retired supervisor bridge and building, Elgin, Joliet and Eastern Railway.

Mr. Marlow: The following is a list of the officers-elect of the Roadmasters and Maintenance of Way Association of America for the administrative year 1988-1989. The officers so named please step forward and take a position on my left.

For President, E. J. (Al) Matte, supervisor maintenance of way, Canadian Pacific Rail, Toronto, Ontario, Canada; First Vice President, A. Keith Pottorff, assistant general manager-maintenance, Atchison Topeka and Santa Fe Railway, Los Angeles, California; Second Vice President, Jerome D. Cossel, chief engineer design and construction, Conrail, Philadelphia, Pennsylvania. For Treasurer, Stephen J. Hill, assistant regional engineer, Soo Line, Chicago, Illinois.

For Director for terms ending 1992: Johnny M. Johnson, manager maintenance of way training, Atchison, Topeka and Santa Fe Railway, Albuquerque, New Mexico; Kendall F. Koff, supervisor of track, Chicago, Missouri and Western Railway, Springfield, Illinois; Barry C. Mohl, division engineer, Elgin, Joliet and Eastern Railway, Gary, Indiana.

Election to a position of leadership in any organization is an honor not to be taken lightly. Your fellow members in electing each of you to your respective office, have expressed confidence in you, first, that you are to discharge your several duties with distinction. Second, that you are willing to do so.

Mr. Kapp: As the officers of our two Associations, you will represent to the citizens of the United States and Canada, the true meaning of railway bridge and building and roadway maintenance and construction. You will be our collective voice in the industry. Thus, you will be our common bond with railway personnel throughout the United States, Canada and the world.

Mr. Marlow: As the officers of our two Associations you will represent our best interests in any of your activities or projects, always reminding yourselves that your attitude must be a part in any undertaking sanctioned by your respective Associations. In this you will be adhering strictly to the Constitution and By-laws of the two Associations.

As a representative of the Roadmasters and Maintenance of Way Association of America I install each of you in the office to which you were elected in your Association.

Mr. Kapp: As a representative of the American Railway Bridge and Building Association, I install each of you in the office to which you were elected in your Association. Please remain standing so that Mr. Marlow and I may come down and congratulate you. The audience may now applaud.

President Lewis: At this time I would like to call on Mr. Avon Lane, President of REMSA.

Mr. Lane: President Matte, President Tallent, past presidents, members of Roadmasters and Bridge and Building Associations, ladies and gentlemen, it is a distinct pleasure for me as President of REMSA to congratulate your associations on their selections of new officers and members of your board. As most of you know, it has been customary at this time each year for REMSA to present the incoming presidents with a gavel, symbolic of authority during the upcoming terms of office. Therefore, I would like at this time to present this gavel to Al Matte, President of the Roadmasters and Maintenance of Way Association of America. (Applause)

President Matte: Thank you, Avon.

Mr. Lane: You're welcome. Congratulations, Al, and very best wishes for a successful year.

And now, on behalf of REMSA, I would like to present this gavel to the new president of the American Railway Bridge and Building Association, Mr. Ray Tallent. (Applause)

Mr. Tallent: Thank you.

Mr. Lane: Very best wishes to you as well, Ray. And now before presenting the REMSA gold pin awards to outgoing presidents Lewis and Snyder, I want to thank them and all members of their boards for the excellent cooperation REMSA has received during the past year. On behalf of our membership I would like at this time to present this pin to Don Lewis. It reads, "D. J. Lewis, President American Railway Bridge and Building Association, 1987-1988". And now to Ray Snyder, a matching pin, which reads, "R. E. Snyder, President Roadmasters and Maintenance of Way Association of America, 1987-1988." Thank you very much for your attention. (Applause)

President Lewis: In my closing remarks, I gave condolences to Pat Weissmann and Barbara Marlow last year when I took over this office, I think it is appropriate now to congratulate them. They have been able to put up with me for a year. I want to thank them for all their help, the Board that helped put together this very good conference, and also our railroads. If it weren't for the backing of our railroads we wouldn't have this association. They help us come to these meetings, supply information for our different special subjects, and it is through all of this participation that we exist. Thank you. (Applause)

At this time I would like to present the new president of the American Railway Bridge and Building Association, Mr. Ray Tallent.

President-elect Tallent: I have a plaque here in recognition of Don's outstanding service as President for the last year. It says, ''American Railway Bridge and Building Association, presented to Donald J. Lewis for his services as President 1987-1988 and Vice President 1984-1987.'' (Applause)

President Lewis: Thank you, Ray.

President Tallent: We have just finished another successful conference here in Chicago. Now it is time to get ready for the conference in Toronto which will be next year in conjunction with REMSA's equipment show. The work starts now for next year. Don put on a successful program this year through your help, and that's what we are asking for next year. The new officers and directors of this Association have accepted the challenge to take this Association forward. Now what we need to do is challenge you. Because we work for you. We work for the members of the Association. We need your involvement and your help to continue to move the Association forward and also to continue to have the conferences as successful as they have been in the past. We are asking your involvement, not only in filling out these cards for the special subjects that we have next year, but also to provide information, so that these special subjects will have meaning and we will be able to present on the program meaningful information to the people to take back home. Fill those out and give us the information. But also we want to challenge you to help us in increasing our membership. The railroads all over the country have downsized. We are all a part of that. We are doing more with less. We have bigger territories. We have less in our budgets. But also we have young people coming on board. Younger supervisors, new supervisors. We need to get them involved. We need to get them as part of the membership. We also need to make an effort to bring more of the short lines, more of the regionals, more of the metros into our association and help provide us information with which we can help them. The Association is here for you. Let us know what we can do to help you. I will be here this year. You can get in touch with me through the Secretary's office and also any of our vice presidents and directors. So looking forward to the next year, we are looking forward to a good program in Toronto. If you have any questions or anything we can do, let us know. Thank you. (Applause)

President Snyder: Well, I think it has been a good conference, and I hope you do too. It has been an honor to serve as president of the Roadmasters and Maintenance of Way Association, and I would like to thank the members of the Board, Pat Weissmann, Barb Marlow, for this support during the past year. A special thanks to all the members who made presentations at this conference, and to Avon Lane and the REMSA organization for their continued support of our organization during this past year. In January I will celebrate 20 years with this organization, and I can truly say that the benefits to me and my company have vastly outweighed my contribution to this organization. However, I pledge to continue to support this organization in an attempt to repay this debt. I can assure you that any support you give the organization will be repaid to you one hundredfold. Thank you. (Applause)

At this time I would like to present Al Matte with his Roadmasters' pin. Al.

President-elect Matte: Before you go away, Ray, I would like to give you this plaque which is an appreciation award. It reads, ''Presented by the Roadmasters and Maintenance of Way Association of America to R. E. Snyder for his services as President 1987-1988.''

President Snyder: Thank you, Al. (Applause)

President Matte: I am deeply honored and very proud to be elected to the position of President of this great Association. I pledge to you together with the members of the Board of Directors that I will handle the affairs of this Association to the best of my ability. I would be remiss at this time if I did not recognize the wives of the officers, especially my wife, Pat, who is in the audience, and I would like her to stand. (Applause) Their interest, participation,and love are important to the success of our association. Thank you ladies.

This year marks the 100th anniversary of the Roadmasters Proceedings publication and 106th year of our existence, a feat which is the envy of many other organizations and one of which every member should be proud. To the railway managements of the past and present, sincere thanks for your support.

This next year (1989) brings the Association to a REMSA show year which will be held for the first time outside of the United States. As a Canadian citizen and especially as the third Canadian to serve as President of the Roadmasters Association, I look forward to being part of the coming activities. Toronto, Canada, the people city, awaits all, the Roadmasters, B&B, REMSA, and AREA with open arms, and I extend my own personal welcome to you to our great country. I hope to see you all in 1989 in Toronto. Thank you. (Applause)

I would like to add to what Ray said: you people are the backbone of the Associations, we need your support, and we need all the help that you can possibly give us and especially for committee chairmanships. We always seem to have some problems in finding chairmen. Please feel free to come forward and volunteer to chair a committee for next year. We welcome you with open arms.

This, ladies and gentlemen, concludes the 1988 Roadmasters and B&B Associations conferences.

Adjourn

Past Officers

	1891-1892	1892-1893	1893-1894	1894-1895
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V.-Pres.	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-1896	1896-1897	1897-1898	1898-1899
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres.	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres.	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres.	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	L. J. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. G. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H Reid
2nd V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H Rettinghouse	W O Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	W. O Eggleston	H. H Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H Reid	J. P. Canty	H Rettinghouse	H Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H Rettinghouse	F. E. Schall	F. E. Schall	A E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J N. Penwell
4th V.-Pres.	W. O Eggleston	A. E. Killam	J N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P Canty	J P Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullen	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnson	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	P. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934–1935	1935–1936	1936–1937	1937–1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938–1939	1939–1940	1940–1941	1941–1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary	....	....	F. O. Whiteman	A. G. Shaver
Treasurer	....	....	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942–1943	1943–1944	1944–1945	1945–1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

† To November 1, 1942 ‡ To February 1, 1943

	1946–1947	1947–1948	1948–1949	1949–1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
Directors	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	J. A. Jorlett

	1950–1951	1951–1952	1952–1953	1953–1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells
	J. A. Jorlett	J. F. Warrenfells	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells	W. H. Bunge
	J. F. Warrenfells	B. M. Stephens	G. Switzer	E. R. Schlaf

	1954–1955	1955–1956	1956–1957	1957–1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	H. H. Matthews
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	T. M. VonSprecken
	H. D. Curie	E. R. Schlaf	T. M. VonSprecken	W. H. Bunge
	J. M. Lowry	G. W. Benson	H. A. Matthews	E. R. Schlaf

	1958–1959	1959–1960	1960–1961	1961–1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	R. C. Baker	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962–1963	1963–1964	1964–1965	1965–1966
President	J. M. Lowry	E. R. Schlaf	R. C. Baker	H. M. Wilson
1st V.-Pres.	E. R. Schlaf	R. C. Baker	H. M. Wilson	R. D. Hellweg
2nd V.-Pres.	H. A. Matthews	Shirley White	R. D. Hellweg	J. W. DeValle
3rd V.-Pres.	R. C. Baker	H. M. Wilson	J. W. DeValle	W. F. Armstrong
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	E. F. Snyder	E. F. Snyder	E. F. Snyder
Directors	Shirley White	R. D. Hellweg	W. F. Armstrong	J. A. Goforth
	H. M. Wilson	F. W. Hutcheson	J. S. Ellis	E. R. Simmons
	R. D. Hellweg	W. F. Armstrong	J. A. Goforth	N. D. Bryant
	F. W. Hutcheson	J. W. DeValle	E. R. Simmons	A. R. Dahlberg
	W. F. Armstrong	J. A. Goforth	N. D. Bryant	J. S. Ellis
	J. W. DeValle	E. R. Simmons	A. R. Dahlberg	T. L. Fuller

	1966–1967	1967–1968	1968–1969	1969–1970
President	R. D. Hellweg	J. W. DeValle	W. F. Armstrong	J. A. Goforth
1st V.-Pres.	J. W. DeValle	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg
2nd V.-Pres.	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg	T. L. Fuller
3rd V.-Pres.	J. A. Goforth	A. R. Dahlberg	T. L. Fuller	N. D. Bryant
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	N. D. Bryant	J. S. Ellis	N. F. Lucas	W. H. Rankin
	A. R. Dahlberg	T. L. Fuller	W. L. Short	E. E. Runde
	H. F. Lucas	R. A. Youngblood	C. E. Wachter	T. A. Reynolds
	J. S. Ellis	H. F. Lucas	A. C. Jones	J. J. Ridgeway
	T. L. Fuller	W. L. Short	W. H. Rankin	J. R. Williams
	R. A. Youngblood	C. E. Wachter	E. E. Runde	J. W. Chambers
	V. D. Raessler	A. C. Jones	T. A. Reynolds	R. E. Frame
	W. L. Short	W. H. Rankin	J. J. Ridgeway	J. C. Hobbs
	C. E. Wachter	E. E. Runde	J. R. Williams	

	1970–1971	1971–1972	1972–1973	1973–1974
President	A. R. Dahlberg	T. L. Fuller	N. D. Bryant	E. E. Runde
1st V.-Pres.	T. L. Fuller	N. D. Bryant	E. E. Runde	J. J. Ridgeway
2nd V.-Pres.	N. D. Bryant	E. E. Runde	J. J. Ridgeway	J. R. Williams
3rd V.-Pres.	E. E. Runde	J. J. Ridgeway	J. R. Williams	W. R. Rankin
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	T. A. Reynolds	J. W. Chambers	R. K. Corbett	D. C. Gould
	J. J. Ridgeway	R. E. Frame	J. R. Iwinski	W. S. Stokely
	J. R. Williams	J. C. Hobbs	J. S. Pritchett	W. C. Sturm
	J. W. Chambers	R. K. Corbett	D. C. Gould	J. W. Davidson
	R. E. Frame	J. R. Iwinski	W. S. Stokely	C. A. Hughes
	J. C. Hobbs	J. S. Pritchett	W. C. Sturm	W. R. Hyma
	R. K. Corbett	D. C. Gould	J. W. Davidson	O. C. Denz
	J. R. Iwinsky	W. S. Stokely	C. A. Hughes	R. C. McMaster
	J. S. Pritchett	W. C. Sturm	W. R. Hyma	W. E. Brakensiek

	1974–1975	1975–1976	1976–1977	1977–1978
President	J. J. Ridgeway	J. R. Williams	W. H. Rankin	J. R. Iwinski
1st V.-Pres.	J. R. Williams	W. H. Rankin	J. R. Iwinski	W. C. Sturm
2nd V.-Pres.	W. H. Rankin	J. C. Hobbs	W. C. Sturm	D. C. Gould
3rd V.-Pres.	J. C. Hobbs	J. R. Iwinski	D. C. Gould	J. W. Chambers
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	J. W. Davidson	W. E. Brakensiek	J. W. Chambers	W. J. Gunkle
	C. A. Hughes	O. C. Denz	M. Noyszewski	W. E. Halley
	W. R. Hyma	R. C. McMaster	W. J. Gunkle	K. L. Wammell
	W. E. Brakensiek	F. R. Lindsay	W. E. Halley	J. Budzileni
	O. C. Denz	M. Noyszewski	K. L. Wammel	B. J. King
	R. C. McMaster	W. C. Sturm	J. Budzileni	J. G. Robertson
	F. B. Lindsay, Jr.	W. J. Gunkle	B. J. King	O. C. Denz
	M. Noyszewski	W. E. Halley	J. G. Robertson	E. C. Patterson
	Jim Payne	K. L. Wammel		W. S. Stokely

	1978–1979	1979–1980	1980–1981	1981–1982
President	W. C. Sturm	D. C. Gould	J. W. Chambers	W. R. Hyma
Sr. V.-Pres.	D. C. Gould	J. W. Chambers	R. C. McMaster	O. C. Denz
Jr. V.-Pres.	J. W. Chambers	R. C. McMaster	W. R. Hyma	J. Budzileni
Jr. V.-Pres.	R. C. McMaster	W. R. Hyma	O. C. Denz	J. M. Williams
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Pat Weissmann
Treasurer	W. F. Armstrong	W. F. Armstrong	W. F. Armstrong	W. C. Sturm
Directors	J. Budzileni	O. C. Denz	J. W. Davidson	D. A. Bessey
	B. J. King	W. J. Gunkle	C. M. Russell	J. N. Michel
	J. G. Robertson	W. S. Stokely	J. M. Williams	P. H. Saletnik
	O. C. Denz	L. D. Green	D. A. Bessey	O. D. Anthony
	E. C. Patterson	C. M. Russell	J. N. Michel	J. T. Kapp
	W. S. Stokely	J. M. Williams	P. H. Saletnik	D. J. Lewis
	L. D. Green	D. A. Bessey	O. D. Anthony	J. W. Davidson
	C. M. Russell	J. N. Michel	J. T. Kapp	H. J. Laga
	J. M. Williams	P. H. Saletnik	D. J. Lewis	A. S. Uppal

	1982–1983	1983-1984	1984-1985	1985-1986
President	O. C. Denz	J. Budzileni	J.M. Williams	D. A. Bessey
Sr. Vice President	J. Budzileni	J.M. Williams	D.A. Bessey	J. T. Kapp
Jr. Vice President	J. M. Williams	D.A. Bessey	J.T. Kapp	D. J. Lewis
Jr. Vice President	D. A. Bessey	J.T. Kapp	D.J. Lewis	R. A. Tallent
Secretary	P. A. Weissmann	P.A. Weissmann	P.A. Weissmann	P. A. Weissmann
Treasurer	P. H. Saletnik	P.H. Saletnik	P.H. Saletnik	J. M. Williams
Directors	O. D. Anthony	J.W. Davidson	T.E. Kuhn	B. T. Burns
	J. T. Kapp	D.J. Lewis	D.R. Ladner	J. J. Horney
	D. J. Lewis	T.E. Kuhn	R.A. Tallent	W. J. Semioli
	J. W. Davidson	D.R. Ladner	B.T. Burns	R. E. Fronczak
	H. J. Laga	R.A. Tallent	J.J. Horney	W. P. Cunningham
	A. S. Uppal	B.T. Burns	W.J. Semioli	J. H. Smith
	T. E. Kuhn	J.J. Horney	D.W. Brookings	E. Bond
	D. R. Ladner	W.J. Semioli	W.P. Cunningham	D. L. Steele
	R. A. Tallent		J.H. Smith	M. C. Walbrun

	1986-1987	1987-1988	1988-1989
President	J. T. Kapp	D. J. Lewis	R. A. Tallent
Sr. Vice President	D. J. Lewis	R. A. Tallent	B. T. Burns
Jr. Vice President	R. A. Tallent	B. T. Burns	J. J. Horney
Jr. Vice President	B. T. Burns	J. J. Horney	M. C. Walbrun
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	J. M. Williams	J. M. Williams
Directors	W. H. Nelson	M. C. Walbrun	C. E. Thompson
	J. H. Smith	S. Lipkus	H. L. Davidson
	J. J. Horney	D. L. Steele	J. A. VanHuis
	M. C. Walbrun	C. E. Thompson	W. H. Nelson
	E. Bond	H. L. Davidson	T. J. Parker
	D. L. Steele	J. A. VanHuis	R. C. Karsten
	C. E. Thompson	W. H. Nelson	S. Lipkus
	H. L. Davidson	T. J. Parker	T. V. Dunn
	J. A. VanHuis	R. C. Karsten	M. L. Bradley

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1.** The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings, water service facilities, and other structures, by investigation, reports and discussions.

Section 2. The association shall neither endorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussion unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1.* The membership of this association shall be divided into four classes, viz: Members, life members, associate members and honorary members.

Section 2.* A member shall be a person in a position above rank of gang foreman in connection with engineering, construction and maintenance for railway bridges, buildings and water service facilities: or in the employ of a public regulatory body, a professor of engineering or architecture, a technical editor, a government or private timber expert, a consulting engineer, or an engineer in his employ, engaged in the engineering, construction and maintenance of railroad-related facilities or an engineer employed by a technical service or research and development organization, an officer or engineer of an engineering or scientific society or association whose aims and objectives are compatible with the aims and objectives of this association. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3.** To be eligible for a life membership a member must have belonged to the association for at least 15†† years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2 of this Article.

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*Amended September, 1976.

**Amended September 20, 1948

††Amended March 10, 1958.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of members except that of holding office and shall be exempt from the payment of dues.

Section 6. Any member guilty of conduct unbecoming to a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 7. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 8.** Only members shall hold office in this association, and only members and life members shall be entitled to vote in the election of officers.

ARTICLE IV.

OFFICERS

Section 1‡‡. The officers of the Association shall be a President, two Junior Vice Presidents, a Senior Vice President, a Treasurer and nine Directors, who, with the most recent Past President, shall constitute the Executive Committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1.** The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND SECRETARY AND TENURE OF OFFICE

Section 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any member of the

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*Amended October 16, 1941.
†Amended September 21, 1957.
‡Amended September 28, 1966.
‡‡Amended September 20, 1978.
° Amended October 7, 1982.

association not in arrears for dues shall be eligible for office, but the president shall not be eligible for re-election.

Section 2[††]. The President, two Junior Vice Presidents, and Treasurer shall hold office for one year and the Directors for three years; three Directors being elected each year. The Senior Vice President shall hold office for one year and ascend to the office of President at the expiration of such service. All officers shall retain their office until their successors are elected and installed. A Director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3.[°] The term of office of the treasurer may be terminated at any time by two-thirds vote of Executive Committee. The compensation of the treasurer shall be fixed by a majority vote of the Executive Committee.

Section 4.[°] The secretary shall be appointed by a majority vote of the Executive Committee and the term shall terminate with the appointment of successor. The Executive Committee shall have the power, by two-thirds vote, to remove the secretary and appoint successor at any time. The salary of the secretary shall be decided by a majority vote of the Executive Committee.

Section 5.[°] The secretary and the treasurer shall be required to give bond in an amount to be fixed by the Executive Committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1[†]. Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears, may be stricken from the list of members at the discretion of the executive committee.

Section 2.[‡] A person stricken from the list of members because of non-payment of dues, upon written application may be reinstated as a member in his former class without loss of privileges, either upon payment of all back dues (which must accompany applications) or at the discretion of the executive committee voting in the manner prescribed in Section 2, Article III.

ARTICLE VIII.[*]

LOCAL SECTIONS

Section 1.[**] Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

By-Laws

TIME OF MEETING

1.[**] The regular meeting of this association shall convene annually during the month of September, the exact date to be fixed by the executive committee.

PLACE OF MEETING

2.[**] The place of holding the annual convention shall be Chicago, Ill.

3. It shall be within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

[***]DUES

5. The annual dues for the fiscal year ending August 31, and payable in advance, shall be as follows:[°]

Members, $20.00; Associate Members, $20.00.[‡]

DUTIES OF OFFICERS

6.[†] The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7.[‡‡] The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President and discharge his duties in case of a vacancy in his office. The Senior Vice President shall have the senior position of Vice Presidents.

8.[†] It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts, between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.[‡] The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10.[#] After each annual meeting the president shall appoint a committee consisting of five members. Two Past Presidents shall be members of this committee, one of whom shall act as Chairman. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual convention in accordance with ARTICLE VI of the Constitution, said list to be read at the business session of said convention. Nothing in this section shall be construed to prevent any member making further nominations provided that such nominations are received by the President in writing not less than thirty (30) days in advance of the first day of the annual meeting. Such nominations should be addressed to the President of the Association at its headquarters office.

[‡] Adopted October 17, 1940.

[#] Amended March 23, 1983.

[†] Amended September 20, 1948.

[‡] Amended September 21, 1957.

[‡‡] Amended September 20, 1978.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to cooperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDERS OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's rules of order.

AMENDMENTS

17.† The By-Laws can be amended by a two-thirds vote of those present at any regularly called executive committee meeting.

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†Amended September 20, 1948.
*Article adopted 1922.
**Amended September 20, 1948.
‡Amended September 21, 1957.
***Amended September 15, 1965.
§Amended June 8, 1984

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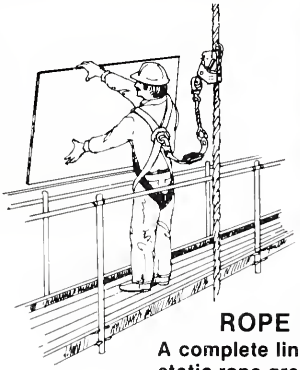

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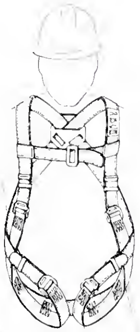

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ACTIVE MEMBERS

	Joined
Adams D A, Gen B&B Supv, UP RR, 2333 Walnutwood, Baton Rouge, LA 70816	09-26-84
Alexander R W, President, Technical Team Services Inc, 8031 W Center Rd #100, Omaha, NE 68124	06-12-87
Allen J P, Engr Strs, NS Corp, 99 Spring St, Atlanta, GA 30303	09-20-87
Anderson B R, Sr Strc Insp, Conrail, 1634 6 Penn Center, Philadelphia, PA 19103	10-04-82
Anderson N M, Supv Br Mtce, UP RR, 1416 Dodge St, Omaha, NE 68179	09-30-88
Anderson T C, Dsgn & Const Mgr, Schnabel Foundation Co, 210 Cleveland St, Cary, IL 60013	08-10-83
Anderzunas P P, Asst Div Engr, Conrail, 211 Knotty Oak Dr, Mt Laurel, NJ 08060	05-08-84
Anthony O D, Chf Engr, B&A RR, North Maine Junct Pk,RR 2, Bangor, ME 04401	10-05-71
Armenta C G, Supv Strs, AT&SF RY, 12969 Road 37, Madera, CA 93637	10-07-82
Bagwell M W, Chf Engr, Mississippi Export RR, PO Box 743, Moss Point, MS 39563	03-16-88
Bailey J, Supv B&B Dept, METRA, 14736 S Major, Oak Forest, IL 60452	08-31-77
Baker R C, Mgr Wrk Equip, EJ&E RY, PO Box 880, Joliet, IL 60434	09-14-80
Banicki R J, Engr Const & Facil Ops, IC RR, 233 N Michigan Ave, Chicago, IL 60601	04-02-86
Banks E G, Supv Scales, SP Trans Co, 1 Market Plaza Rm 1007, San Francisco, CA 94105	04-29-83
Barber S E, Proj Engr, Conrail, 15 N 32nd St, 10th Flr, Philadelphia, PA 19104	12-17-87
Barrett J E, Sr VP, Alfred Benesch & Co, 233 N Michigan, Chicago, IL 60601	12-09-71
Barrett P L, Engr Const & Mtce, AT&SF RY, 7500 Jefferson St NE Bldg #2, Albuquerque, NM 87109	02-17-82
Bartholomew D E, Sr Proj Mgr RR Facilities, Sverdrup Corp, 1200—112th Ave NE POB 369, Bellevue, WA 98009	09-15-86
Bateman J D, B&B Supv, UP RR, 8831 Silent Stream, San Antonio, TX 78250	12-03-82
Battle, Jr E A, Sr Engr Shops & Yards, Metro North Commuter RR, 347 Madison Ave, 11th Flr, New York City, NY 10017	09-21-87
Beattie G W, Asst Supt Mtce, AT&SF RY, PO Box 1763, Pearland, TX 77588	11-05-82
Beebe L C, Mgr Sfty Srvcs, UP RR, 1416 Dodge St, Omaha, NE 68179	12-04-85
Begnaud R A, Asst Engr/Br Dsgn, Amtrak, 2961 Hale St, Philadelphia, PA 19149	05-08-84
Beirne J M, Mgr Trk Insp, NS Corp, 8 N Jefferson St-Box 52, Roanoke, VA 24042	08-20-76
Benes R F, Resident Engr, DeLeuw Cather & Co, 3955 Yale St, Hamburg, NY 14075	04-27-87
Bennett R M, Rsrch Anlyst-Ind Dvlpmnt, NS Corp, 185 Spring St SW, Atlanta, GA 30303	08-17-88
Benson D D, Envir Engr, UP RR, 5631 S Park Pl W, Salt Lake City, UT 84121	08-10-72
Benton, III W, Asst Engr Bridges, NS Corp, 99 Spring St SW, Atlanta, GA 30303	08-17-88
Beran J R, Chf Engr-Design, UP RR, 1416 Dodge St Rm 920, Omaha, NE 68179	09-07-83
Bessey D A, Sr Arch (Ret), Envirodyne Engineers Inc, 1315 S Charlotte, Sarasota, FL 34239	08-31-77
Bhalakia M P, Dsgn & Constr Engr, P&LE RR, Store House A, McKees Rocks, PA 15136	09-16-73
Bibly K C, Mgr Pwr Hse, Amtrak, 210 S Canal St, Chicago, IL 60606	10-10-67
Billings J D, B&B Supv, C&NW Trans Co, 375 Beech St, Chadron, NE 69337	10-03-74
Billingsley R E, Gen B&B Supv, NS Corp, 8 N Jefferson St, Roanoke, VA 24042-0049	12-05-86
Binkley W O, Gen Supv Br, CSX Transportation, PO Box 18052, Jacksonville, FL 32229	10-18-79
Birgenheier J A, Sr Insp-Engr Mtls, BN RR, 9401 Indian Creek Pkwy, Overland Park, KS 66216	02-06-89
Bishop G L, Strl Dtlr, NS Corp, 99 Spring St, Atlanta, GA 30303	09-20-87
Boileau R J, Reg Engr, BN RR, 3253 E Chestnut Expwy, Springfield, MO 65802-9136	03-27-85
Bonas D J, Asst Engr, NS Corp, 99 Spring St SW, Atlanta, GA 30303	11-02-83
Bond E, Chf Engr Br & Strs, NS Corp, 99 Spring St SW, Atlanta, GA 30303	09-28-66
Boraas R S, Engr Of Strs, D&RGW RR, PO Box 5482, Denver, CO 80217	10-02-86
Borg M T, Gen Supv B&B, BN RR, 20412 Tallman Dr, Parker, CO 80134	02-24-84
Boyd J E, Mgr Ties, AT&SF RY, 7500 Jefferson St NE-Crtyrd 2, Albuquerque, NM 87109	10-04-82
Bradley M L, Proj Engr, Conrail, 3209 Heatherside Dr, Dublin, OH 43017	08-31-82
Brashares R E, B&B Supv, CSX Transportation, PO Box 414, Montgomery, AL 36101	09-11-69
Brookings D W, Chf Engr, KCS RY, 114 W 11th St, Kansas City, MO 64105	09-26-77
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Budzileni J, Sr Strl Dsgnr (Ret), ICG RR, 1315 W Elmdale Ave, Chicago, IL 60660	10-16-63
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Burris H A, Asst Div Engr (Ret), AT&SF RY, 36894 Hayward, Barstow, CA 92311	01-28-72
Burrows F G, Consl Engr (Prof Of Engr), CA State U, 427 Bayside Rd, Apt B, Arcata, CA 95521	10-10-73
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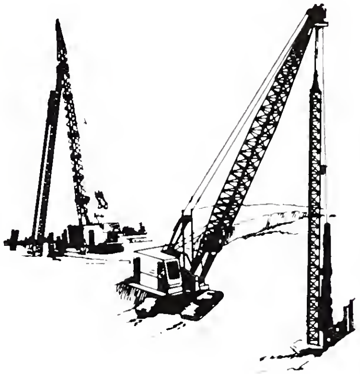

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Lipkus S, Head Of Strl Engr, Deluc Consulting Engineers, 5160 Decarie Blvd, Ste 770, Montreal,QUE,Canada,H3X 2H9	06-04-82
Lloyd H R, B&B Supv, NS Corp, PO Box 471, Stockbridge, GA 30281	09-28-66
Lloyd S M, B&B Supv, NS Corp, 8 N Jefferson St, Roanoke, VA 24042-0049	08-17-88
Longiotti P, Supv Strs & Trk, B&LE RR, PO Box 471, Greenville, PA 16125	10-22-74
Lott D W, Strs Supv, C&NW Trans Co, 301 N Lake St, Northlake, IL 60164	09-15-86
Loyd T R, Insp, UP RR, PO Box 9837, Ft Worth, TX 76114	09-17-85
Lozano D E, Asst Mgr Strs, AT&SF RY, PO Box 3933, Crestline, CA 92325	03-07-79
Lund C R, Asst Engr Bldgs, Soo Line, PO Box 530, Minneapolis, MN 55440	09-03-71
Lurcott E T, Engr Sys Insp Strs, Conrail, 6 Penn Center Rm 1640, Philadelphia, PA 19104	01-10-66
Luzier W B, President, LZR Engineering, PO Box 252, Stone Mountain, GA 30086	10-17-85
Lynch J F, Chf Engr, Santina & Thompson Inc, 1040 Oak Grove Rd, Concord, CA 94518	08-31-59
Mader C E, Asst Engr-Const & Mtce, AT&SF RY, 7500 Jefferson St NE, Ctyrd II, Albuquerque, NM 87109	12-12-88
Makarowski S, Bldg Mgr (Ret), CN RY, 5808—94th Ave, Edmonton,ALB,Canada,T6B 0X8	09-16-64
Marlow M J, Sr Proj Engr-Trks & Prop, EJ&E RY, PO Box 880, Joliet, IL 60434	03-28-72
Marshall J K, Civil Engr, G&W RR, 3 Parkway, PO Box 247, Leicester, NY 14481	01-28-88
Martin C S, B&B Supv, Alaska RR, Pouch 7-2111, Anchorage, AK 99510-7069	09-19-88
Martin, Jr B T, Associate, Mojeski & Masters, 1055 St Charles Ave, Ste 510, New Orleans, LA 70130	04-26-88
Mascorro F F, Gen Frmn (Ret), AT&SF RY, 6213 Warrington Pl, Ft Worth, TX 76112	01-28-72
Maupin A J, Technologist, Alfred Benesch & Co, 440 E Vallette, Elmhurst, IL 60126	09-16-81
Mazzaferro N, Engr Of Stndrds & Fac, LI RR, Jamaica Station, Jamaica, NY 11435	06-17-87
McCammon D L, Mgr B&B, BN RR, 2718 Montana Ave, Billings, MT 59105	08-24-84
McCardle T W, Ry Trk Insp, AL Pub Srvc Comm, PO Box 991, Montgomery, AL 36130	08-20-76
McCloe, Jr. W R, Reg Asst Supvr Strs, Conrail, 208 Howe, Spring Arbor, MI 49283	08-18-87
McDaniel P G, B&B Supv, NS Corp, 8 N Jefferson St, Roanoke, VA 24042-0049	12-05-86
McFarland D E, Supv Strs, AT&SF RY, PO Box 12, Belen, NM 87002	02-19-85
McFarlin R J, Vice President, BKBM Engineers, 219 N Second St, Minneapolis, MN 55401	11-02-83
McGill J A, B&B Supv, NS Corp, 308 Newman St, Hattiesburg, MS 39401	08-25-70
McGinley M E, Rail Group Leader, Daniel Mann Johnson Mendenhall, 275 W Hospitality Ln, Ste 314, San Bernardino, CA 92408	05-08-84
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McLeman J D, B&B Master, CP Rail, 90 Baker St, Nelson,BC,Canada,V1L 4G8	08-18-87
McLeod J N, Proj Engr Strs-Ops, CN RY, 935 LaGauchetiere St W-13th Fl, Montreal,QUE,Canada,H3B 2M9	06-02-88
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McQuitty J M, Strs Supv, C&NW Trans, 500 W Madison St, Chicago, IL 60606	09-19-88
Meeker D L, Asst Dir Stations-Sys, Guilford-Rail Div, 728 S 33rd St, Mattoon, IL 61938	02-22-83
Meisner D C, Asst Br Engr, C&NW Trans Co, 165 N Canal St, Chicago, IL 60606	09-12-76
Michael R G, President, CDC Svcs Inc, 508 W 56th St, Hinsdale, IL 60521	02-19-85
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Morris D A, Asst Div Mgr, AT&SF RY, 6400 Dorado Beach NE, Albuquerque, NM 87111	11-05-82
Morton D M, B&B Supv, Term RR Assn Of St Louis, 2016 Madison Ave, Granite City, IL 62040	10-02-86
Munoz J M, Br Const Engr, UP RR, 24125 Aldine-Westfield Rd, Spring, TX 77373	09-13-81
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Nelson H F, Dir Engrg Svcs, EJ&E RY, PO Box 880, Joliet, IL 60434	09-28-70
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Nesbitt S A, Sr Strl Engr, LoBuono, Armstrong & Assocs, 4950 W Kennedy #600, Tampa, FL 33609	08-12-81
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Oncu I, Mgr Br & Tnl Dsgn, Amtrak, 2000 Market St, 6th Flr, Philadelphia, PA 19103	06-08-84
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Paxton W R, Chftrk Sfty Rsrch, FRA, 9609 Heathergreen Dr, Manassas, VA 22111	09-18-72
Payne R, Vice President, ESCA Consultants Inc, POB 159- 1606 Willow View, Urbana, IL 61801	08-28-85
Payton J H, President & CEO, Ecotech, Inc, PO Box 37712, Omaha, NE 68137	08-17-88
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Peters D R, Gen B&B Supv, UP RR, 121 W 15th St, Cheyenne, WY 82001	03-27-85
Peterson A, Sr Inst Trk & Strs, Amtrak, 2000 Market St, 7th Flr, Philadelphia, PA 19103	09-20-87
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Reeves A N, Sr Strl Engr, Capitol Engineering Corp, PO Box 445, Dillsburg, PA 17019	08-25-88
Reynolds T A, Sr Ind Engr, Conrail, 31 E Georgia St, Indianapolis, IN 46204	09-19-61
Rich T, Asst Supv Strs, Conrail, 1848 Gardenstone Dr, Worthington, OH 43085	12-05-88
Richstein J L, Asst Engr Strs, NS Corp, 99 Spring St-Bridge Dept, Atlanta, GA 30303	09-14-86
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Sanders M R, Principal Engr, Fluor Transportation, 400 Madison Ave, Ste 901, New York, NY 10017	11-02-83
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Schoen W F, Asst Chf Engr Const, Conrail, 15 N 32nd St Rm 1200, Philadelphia, PA 19104	08-12-81
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Semioli W J, Assoc Pub & Editor, Concrete International, Box 19150, Detroit, MI 48219-0150	09-18-78
Shamblin H A, Dir Nuclear Cntrctng, Carolina Power & Light Co, 7709 Harps Mill Rd, Raleigh, NC 27615	12-14-65
Shaw D E, Gen B&B Supv, UP RR, 1000 W 4th St, N Little Rock, AR 72114	09-23-84
Sheffield J J, B&B Supv, CSX Transportation, Box 574AA Rt 3, Effingham, SC 29541	06-06-72
Sheldon E B, Plant Mgr-Crosstie, FEC RY, 7160 Phillips Hwy, Jacksonville, FL 32216	12-06-85
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Shostak M J, Supv B&B, EJ&E RY, 1810 Heather Way Lane #1-F, New Lenox, IL 60451	02-06-89
Simmens S P, Term Frmn B&B, Ontario Northland RY, 555 Oak St E, North Bay,ONT,Canada,P1B 8L3	04-27-87
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Skillman G I, Sr Str Engr, Daniel Mann Johnson Mendenhall, 910—15th St, Ste 500, Denver, CO 80123	10-22-87
Skinner T A, Br Engr, Howard Needles Tammen & Bergendoff, PO Box 419299, Kansas City, MO 64141-6299	12-17-87
Skopitz R J, Strl Dtlr, NS Corp, 99 Spring St, Atlanta, GA 30303	09-20-87
Slone V L, Supv Strs, AT&SF RY, 315 W Avenue B, Temple, TX 76503-0967	06-12-87
Smedley E F, Mgr B&B Mtce, UP RR, 121 W 15th, Cheyenne, WY 82001	09-07-83
Smith C D, Supv Strs, AT&SF RY, 1100 S Garfield, Amarillo, TX 79102	03-28-84
Smith J R, Mgr Engrng, RF&P RR, PO Box 11005, Richmond, VA 23230	09-12-76
Smith J H, Engr-Bldgs & Facil, IC RR, 233 N Michigan Ave, Chicago, IL 60601	09-19-73
Smithberger T P, Dir Of Engr, AREA, 50 F St NW, Ste 7702, Washington, DC 20001	10-15-79
Snyder J D, Supv Strs & Trk, B&LE RR, PO Box 1828, Butler, PA 16003	09-26-77
Snyder R E, Asst Chf Engr-Mtce, C&NW Trans Co, 165 N Canal, Chicago, IL 60606	09-19-61
Solarte H, Pro Mgr, Bridge Farmer & Assocs, Inc, 1300 S Sherman #290, Richardson, TX 75081	10-16-63
Sorgenfrei D F, Associate, Modjeski & Masters, 1055 St Charles Ave, New Orleans, LA 70130	06-05-81
Spicer C A, Sr Crsng Engr, National Transportation Agency, 1316 Carling Ave, Ottawa,ONT,Canada,K1A 0N9	09-17-85
Stander N R, Mgr B&B Mtce, UP RR, PO Box 339, Dupo, IL 62239	09-26-84
Staplin D E, Dir Quality Cntrl-Engr, CSX Transportation, 500 Water St, Rm 1104-J350, Jacksonville, FL 32202	09-19-88
Stapp B, B&B Prog Supv, UP RR, 1416 Dodge St, Rm 920, Omaha, NE 68179	09-18-88
Stearman J, Res Engr, Amtrak, 1500 N Charles St, Baltimore, MD 21201	12-07-79
Steele D L, Mgr Strl Scheduling, UP RR, 1416 Dodge St, Room 1000, Omaha, NE 68179	11-03-81
Steelman H C, Rdmstr, UP RR, 2855 Pine Valley Rd, San Ramon, CA 94583	06-16-80
Stevenjord R, Gen B&B Supv, Alaska RR, Box 7-2111, Anchorage, AK 99510	09-19-88
Stevenson C J, Prin Engr/Arch, Conrail, 15 N 32nd St, Rm 1100, Philadelphia, PA 19104	09-30-88
Stewart B J, Associate, Riley Park Hayden & Assocs Inc, 136 Marietta St NW, Atlanta, GA 30303	02-19-85
Stiverson J D, B&B Supv, NS Corp, 8 N Jefferson St, Roanoke, VA 24042-0049	12-05-86
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Strelcheck G W, Design Engr, BN RR, PO Box 64960, St Paul, MN 55164-0960	09-20-87
Stultz R C, B&B Supv, NS Corp, PO Box 1010, Bluefield, WV 24701	10-02-86
Sturm W C, Sr Proj Engr, EJ&E RY, PO Box 880, Joliet, IL 60434	03-08-62
Swanson H C, Asst Engr, NS Corp, 99 Spring St SW, Atlanta, GA 30303	10-20-86
Tack H, B&B Frmn, DW&P RY, 1808 S Eighth St, Virginia, MN 55792	11-05-82
Tallent, Jr R A, Div Engr, NS Corp, 100 Norfolk Southern Dr, Irondale, AL 35210	06-05-81
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Tanner R J, Mgr M/W Trng, AT&SF RY, 904 Second St SW, Albuquerque, NM 87102	11-05-81
Tate G K, B&B Supv, IC RR, 410 Edwards Dr, Paducah, KY 42003	08-18-87
Terry G R, B&B Supv, KCS RY, Box 174, Blanchard, LA 71009	04-27-87
Thielemier R L, VP-Engineering, Design Nine, Inc, 9700 Mackenzie Rd-Ste 204, St Louis, MO 63123	02-06-89
Thompson C E, B&B Mstr, CP Rail, 4958 Irmin St, Burnaby,BC,Canada,V5J 1V5	03-01-76
Thompson W C, Dir Research, UP RR, 1667 S 153rd St, Omaha, NE 68144	02-23-81
Toftoy D K, Mgr Fac & Cvl Engrg, EJ&E RY, PO Box 880, Joliet, IL 60434	09-17-75
Truitt G T, Spl Proj Mgr, AT&SF RY, 1170 W Third St, San Bernardino, CA 92410	06-04-82
Turner W R, Dir Engr Sched, UP RR, 1416 Dodge St, Rm 1000, Omaha, NE 68179	01-28-88
Tysinger G L, President, Tysinger Hampton & Partners, PO Box 982, Johnson City, TN 37605	04-29-71
Van Huis J A, Chf Engr-Strs, Wisconsin Central Ltd, PO Box 350, Fond Du Lac, WI 54935	09-17-85
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Viehweg P F, Sr Proj Engr, EJ&E RY, PO Box 880, Joliet, IL 60434	09-28-66
Virgin K, Staff Engr/Asst Trnmstr, Monongahela RY, PO Box 630, Brownsville, PA 15417	02-06-89
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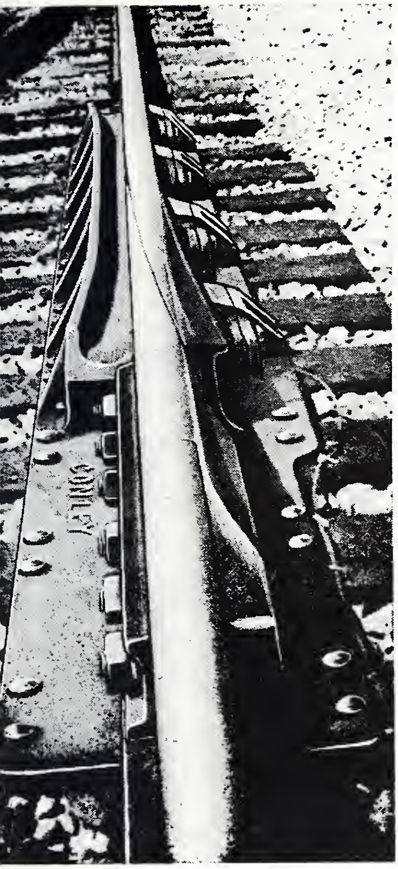

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Weber R W, Supv B&B, EJ&E RY, PO Box 899, Gary, IN 46401	06-02-88
Weinberg M E, Mgr Strs, C&NW Trans Co, 165 N Canal St, Chicago, IL 60606	09-15-86
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Wheeler W A, Asst Engr Br, NS Corp, 99 Spring St SW, Atlanta, GA 30303	11-02-83
Whitney, Jr N E, Consultant, 1613 Cambridge Ave, Flossmoor, IL 60422	09-14-66
Whittaker G E, Engr B&B Prgrms, CSX Transportation, PO Box 45052, Jacksonville, FL 32232-5052	10-20-86
Wilkerson K E, B&B Supv, UP RR, PO Box 207, Caldwell, AR 72322-0207	02-24-84
Willcoxon P W, Cvl Engr, Naval Fac Engrg Command, 200 Stavall St, Alexandria, VA 22332	11-03-81
Williams D E, Asst Supv Strs, Conrail, 2100 Stella Ct, Columbus, OH 43215	12-05-88
Williams J R, Vice President, Alfred Benesch & Co, 233 N Michigan Ave, Chicago, IL 60601	12-07-59
Williams J M, Supv B&B (Ret), EJ&E RY, 5430 E Oak Dr, Newaygo, MI 49337	09-24-63
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Young C W, Proj Engr, Conrail, 264 Earle Dr, Carlton, MI 48117	02-24-84
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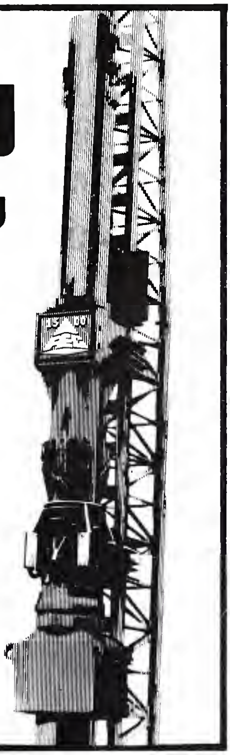
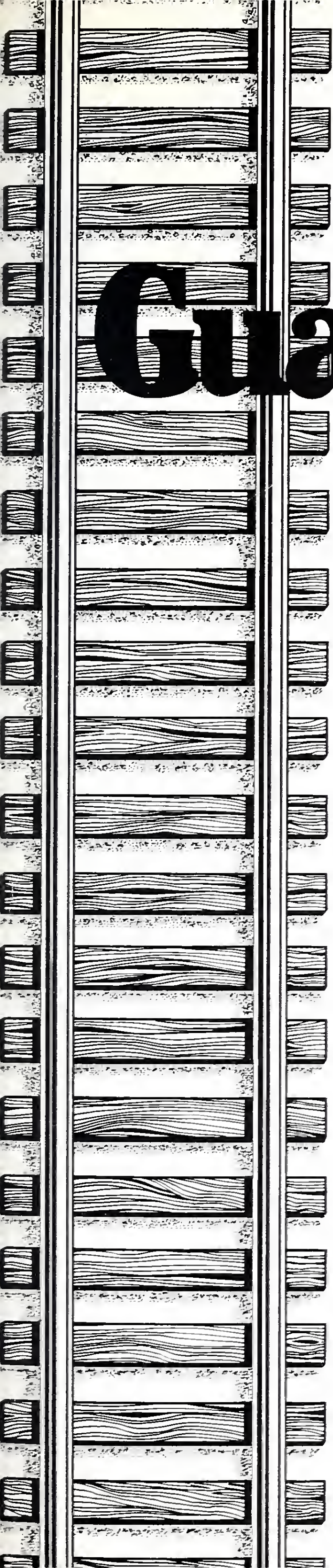


ASSOCIATE MEMBERS

	Joined
Abbott E L, Sls Engr, General Railway Signal Co, 2120 Prudential Plaza, Chicago, IL 60601	11-10-69
Anderson H E, Mgr Oprn, Osmose RR Div, PO Box 8276, Madison, WI 53708	02-20-74
Berkel C J, President, Berkel & Co Contractors Inc, PO Box 335, Bonner Springs, KS 66012	09-28-59
Besl M W, VP, Detzel Construction Co, 2160 Langdon Farm Rd, Cincinnati, OH 45222	03-24-76
Callahan J R, Reg Sls Rep, Speno Rail Srvcs Co, 17120 Kenwood, South Holland, IL 60473	02-23-81
Campbell H D, Campbell R.O.I. Supply, 3062 Bryn Mawr Rd, Montgomery, AL 36111	12-04-61
Carlson N, Fontaine Truck & Equip, 2007 Fern Valley Dr, Louisville, KY 40213	09-26-84
Christenson T J, VP, Chris Construction Corp, 4622 Femrite Dr, Madison, WI 53716	10-03-74
Christiansen G W, Chairman, Racine Railroad Products, PO Box 4029, Racine, WI 53404	10-09-72
Cliff J, VP Sales, SpanDeck, Inc, PO Box 99, Franklin, TN 37065-0099	08-17-88
Conner C, Div Mgr, Carboline Co, 350 Hanley Industrial Ct, St Louis, MO 63144	08-17-88
Cooney J E, VP, F K Ketler Co, 5000 W 69th St, Bedford Park, IL 60638	10-03-85
Coster P, President, Templeton Kenly & Co, Inc., 2525 Gardner Rd, Broadview, IL 60153	09-20-87
Davis J W, Chf Exec Offr, Kershaw Mfg Co, PO Box 17340, Montgomery, AL 36117	02-17-82
Dolan D E, Asst Area Mgr, Osmose RR Div, 1414 Heather, Kearney, MO 64060	09-26-84
Dresden A S, S.A. Alsan & Assoc Inc, 2300 E Higgins Rd, Ste 305A, Elk Grove Village, IL 60007	08-31-77
Drone W, President, Transportation Products Co, 332 S Michigan Ave, Chicago, IL 60604	09-16-81
Dunn R H, President, R H Dunn & Associates Inc, 10608 Orchard St, Fairfax, VA 22030	09-11-68
Emmerich R W, Mgr Of Engrg, Osmose RR Div, PO Box 8276, Madison, WI 53708	10-14-84
Eorgan T D, Sls Engr, Carlisle Syntec Systems, PO Box 7000, Carlisle, PA 17013	03-21-88
Estes C A, Asst Steel Br Frmn, AT&SF RY, 5230 N Broadway, Wichita, KS 67219	04-26-88
Evans R, Agent, Contech Const Prods Inc, 1008 Interloch Ct, Algonquin, IL 60102	08-31-59
Flinn L E, Sls Rep, Western-Cullen-Hayes Inc, 2700 W 36th Place, Chicago, IL 60632	09-14-49
Folk J W, President, Piedmont Railway Supplies Inc, 620 Holcomb Bridge Rd, Roswell, GA 30075	09-12-76
Foraker J W, Reg Mgr-Ind Sls, Burke-Parsons-Bowlby Corp, PO Box 627, Spencer, WV 25276	06-03-83
Foth D D, Exec VP, Natl RR Const & Mtce Assn Inc, 150 S 5th St, #2300, Minneapolis, MN 55402	02-11-86
Gallagher T J, President, Kaufmann-Gallagher Corp, 2647 W 87th St, Evergreen Park, IL 60642	08-17-88
Gallop C M, Manager, Kershaw Mfg—Canada Ltd, 407 Turrene St, Winnipeg,MAN.Canada.R2J 0S5	05-15-74
Gaynor W, President, F K Ketler Co, 5000 W 69th St, Bedford Park, IL 60638	09-17-80
Goray J V, Chf Engr, Graciano Corp, 7925 Hill Ave, Pittsburgh, PA 15221	09-12-76
Hannon T, President, United Right-Of-Way Inc, 314 Larkspur Turn, Peachtree City, GA 30269	09-21-87
Holt D L, President, David L Holt Co Inc, 19715—61st Ave SE, Snohomish, WA 98290	09-17-86
Hunt H W, Dougherty Foundation Prod Inc, P O Box 688, Franklin Lakes, NJ 07417	03-10-72
Hutchinson B, Prod Supv, Wilson Concrete Co, PO Box 7208, Omaha, NE 68107	09-30-88
Klosk M J, President, Railroad Maintenance Corp, 432 Zerega Ave, Bronx, NY 10473	04-01-85
Koch O, Territorial Mgr, Fairmont RY Motors, 1260 Virginia Dr, Fort Washington, PA 19034	02-06-89
Kontonis P, Civil Engr, Panos Kontonis Ltd, 18 K Palama St, Paleo Psychiko 154-52,Athens.Greece.	06-14-85
Kontonis Y P, Civil Engr, Panos Kontonis Ltd, 18 K Palama St, Paleo Psychiko 154-52,Athens.Greece.	08-17-88
Kunstel, Jr D W, Sls Engr, Contech Const Prods Inc, PO Box 285, Vienna, MO 65582-0285	10-20-86
Lamb J H, President, SpanDeck, Inc, PO Box 99, Franklin, TN 37065-0099	08-17-88
Lantz R L, Mktg Mgr-West, Koppers Industries, Inc, 188 Industrial Dr, Elmhurst, IL 60126	12-08-75
Ledingham J B, President, Ocean Coatings Ltd, Box 58354 Station L, Vancouver,BC.Canada.V6P 6E4	11-05-75
Leonard H G, President, Swing-Lo Suspended Scaffold Co, PO Box 128, Covert, MI 49043	08-14-86
Lokey, Jr. L N, Area Mgr, Osmose RR Div, PO Box 117, Griffin, GA 30224	03-25-81
Low D, Mgr Subox Div, Carboline Co, 350 Hanley Ind Ct, St Louis, MO 63144	04-01-85
Lynch J K, Sls Mgr, Vulcan Materials Co, PO Box 7497, Birmingham, AL 35253	09-19-51
Lynde J H, Dist Mgr, Fairmont Railway Motors, 10540 Marty Ste 210, Kansas City, MO 66212	09-15-86
Lynn A, President, Quikbridge, PO Box 7069, Berkeley, CA 94707	03-26-86
Mahoney M W, President, Dodge Engineering Co, 8989 N 138th St, Omaha, NE 68142-1224	09-16-81
Mashburn J I, President, Ozark Railway Supplies, Inc, PO Box 10765, Springfield, MO 65808	12-09-77
Maxa R J, Midwest Sls Mgr, Pileco-Delmag Inc, 27150 Pillsbury Ave, Lakeville, MN 55044	08-10-83
McCabe J, GM, Midwest Industrial Products, 3818 N Clark St, Chicago, IL 60613	09-07-83
McCarthy M F, Chf Est/Heavy Haul, McCarthy Bros Co, 1341 N Rock Hill Rd, St Louis, MO 63124	08-17-88
McComb E, Dist Mgr, Fairmont Railway Motors, Box 196, Champlin, MN 55316	09-26-84
McGuire R F, Area Mgr, Osmose RR Div, 14627 W 89th St, Lenexa, KS 66215	04-29-71
Meyer J J, VP & GM-M/W, Western-Cullen-Hayes Inc, 120 N Third St, Richmond, IN 47374	03-26-80
Milton M A, Sls & Supt, Coastal Gunite Constr Co, 122 McNeeley Dr, LaFollette, TN 37766	01-28-88
Moorhead W H, VP Sls & Engr, Iron Horse Engrg Co Inc, Rt 3, Box 7 (Hwy 386), Port St Joe, FL 32456	09-26-84
Nicely C M, President, The R G Smith Co Inc, PO Box 9067, Canton, OH 44711	11-03-80
Norton K J, VP, Osmose RR Div, POB 8276 - 4546 Tompkins, Madison, WI 53708	03-18-71
Ostby D J, Prod Spec, Osmose RR Div, PO Box 8276, Madison, WI 53708	11-11-85



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Posthauer R J, Partner, Evans & Posthauer Engineers, 99 Railroad Station Plaza, Hicksville, NY 11801	02-23-81
Potter R H, Reid H Potter Assocs Inc, RFD 2 Box 56, Freeport, ME 04032	09-28-66
Pratt C O, Pratt Mtls & Tech Cnsltng Srvcs, Rd 5 Box 332, Valencia, PA 16059	04-30-80
Reilly W C, Chmn Bd-GM, Conley Frog & Switch Co, PO Box 9188, Memphis, TN 38109	04-21-60
Schoulties A P, Svce Engr, Contech Const Prods Inc, 1001 Grove St, Middletown, OH 45044	09-12-75
Scogin V J, President, Standard Materials Inc, 100 W Pennsylvania, Slidelll, LA 70458	09-21-87
Scroggs J E, President, Railway Techniques Inc, 3316 Broadway, Kansas City, MO 64111	02-25-58
Sheets R, President, Sheets Masonary Inc, PO Box 629, Elkview, WV 25071	01-05-89
Shugart F, President, Shugart Mfg Inc, PO Box 748, Chester, SC 29706	09-17-85
Shugart L, Chf Engr, Shugart Mfg Inc, PO Box 748, Chester, SC 29706	09-17-85
Sloat J F, Sr VP Mktg & Sls, Holland Co, 1020 Washington Ave, Chicago Heights, IL 60411	12-12-88
Storer J W, Exec VP, Osmose RR Div, PO Box 8276, Madison, WI 53708	03-06-61
Stout T P, VP, Atlas Services Corp, RD#2 Box 80, Washington, PA 15301	12-08-75
Titus G M, VP Sales, Burke-Parsons-Bowlby, PO Box 231, Ripley, WV 25276	04-26-88
Triplett T, VP, Shugart Mfg Inc, PO Box 748, Chester, SC 29706	09-17-85
Wahl R C, President, Habco Int'L Inc, 930 N Olive, Kansas City, MO 64120	01-28-88
Walsh R H, Gen Sls Mgr (Ret), Holland Company, 394 Church Rd, Elmhurst, IL 60126	03-22-73
Witte R J, Proj Mgr, Detzel Construction Co, 2160 Langdon Farm Rd, Cincinnati, OH 45222	03-28-84
Wood R W, Sls Rep, Vulcan Materials Co, PO Box 7497, Birmingham, AL 35253	10-02-86
Workman M, Plant Mgr, Wilson Concrete Co, PO Box 7208, Omaha, NE 68107	09-30-88
Workman T, Sls Rep, Wilson Concrete Co, PO Box 7208, Omaha, NE 68107	09-30-88

HONORARY MEMBERS

Armstrong W F, Engr Bldgs (Ret), C&NW Trans Co, 5605 Majestic Garden Lks, Bradenton, FL 34203	01-01-47
Denz O C, Supv Bldg Mtce (Ret), CMSP&P RR, 2247 Farnsworth, Northbrook, IL 60062	10-11-67
DeValle J W, Chf Engr Brs (Ret), Southern RY, 629 Brookline Dr, Marietta, GA 30067	08-03-59
Dick M H, VP Editor (Ret), Railway Track & Structures, 369 DesPlaines Ave, Riverside, IL 60546	10-01-37
Gunderson R R, Asst VP (Ret), Western Maryland RY, 689 W Lk Howard Dr #107, Winter Haven, FL 33880	10-01-47
Huffman W H, Asst VP/Ch Engr (Ret), C&NW Trans Co, 42115 Village 42, Camarillo, CA 93010	01-01-41
Jorlett J A, Str Engr (Ret), Penn Central, 7306 Lighthouse Way, Holiday, FL 34691	10-17-40
Runde E E, Const Engr-Strs (Ret), IC RR, 154 Wisconsin Ave, E Dubuque, IL 61025	12-07-59
Schlaf E R, Supt Fire Prev (Ret), IC RR, 2136 W Howland, Chicago, IL 60620	07-02-47
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Baker F A, Gen Br Insp (Ret), SP Trans Co, 2507 Polk St, Eugene, OR 97405	09-18-55
Barr A S, Chf Reg Engr (Ret), Penn Central, PO Box 12967, Pittsburgh, PA 15241-0967	02-10-66
Barsema M, B&B Supv (Ret), C&NW Trans Co, 28W732 Geneva Rd, West Chicago, IL 60185	10-15-58
Bartley C W, B&B Supv (Ret), BN RR, 1706 Pinyon Dr, Laurel, MT 59044	09-04-66
Beaver J F, Chf Engr (Ret), Southern RY, PO Box 1548, Holmes Beach, FL 33509	06-04-68
Bechly D S, Chf Engr Strs (Ret), IC RR, 168 Haywood Knolls Dr, Hendersonvile, NC 28739	06-04-68
Bell D V, Gen Str Supv (Ret), B&O RR, RR 1, Wellston, OH 45692	02-06-57
Beringer M A, Supt Br Erctn (Ret), IC RR, 4013 Noble, Zachary, LA 70701	09-01-29
Bertel D J, Chf Engr Mtce (Ret), MP RR, 3032 Yucca Rd, Willow Park, TX 76086	03-12-68
Bishop D B, VP (Ret), W R Grace Co, 50 Ocean Dr, Punta Gorda, FL 33950	07-18-46
Boehling, Jr. H A, Gen Supv Str (Ret), C&O RY, 1509 W Laburnum Ave, Richmond, VA 23227	10-13-48
Born J O, Chf Engr (Ret), Maine Central RR, 398 Brook St, Westbrook, ME 04092	10-03-56
Bowman R M, Gen Frmn B&B (Ret), Penn Central, Newry Lane, Hollidaysburg, PA 16648	01-05-54
Brakensiek W E, Asst Chf Engr Strs (Ret), MP RR, 10143 Farrington Dr, St Louis, MO 63137	09-12-62
Brietzke W F, GM (Ret), Pettibone, 1150 Tarpon Center Dr, Venice, FL 34285	12-03-56
Bryant N D, Asst Chf Engr/M-S (Ret), BN RR, RR 1 Box 1622, Chandler, TX 75758-9801	04-07-61
Buckmaster W A, Asst Div Engr (Ret), B&O RR, 3265 N Little Horse Dr, Tucson, AZ 85712	09-19-51
Burch E E, Br Engr (Ret), CMSP&P, 14 Eric St, Norwich, NY 13815	03-04-45
Burpee C M, Editor (Ret), Wood Preserving News, 1051 Mountain View St, Hendersonville, NC 28739	01-01-30
Camelle E J, B&B Supv (Ret), SP Trans Co, PO Box 3667, Lafayette, LA 70501	01-05-54
Carlisle R W, B&B Supv, NS Corp, 223 Walnut St, Rm 213, Macon, GA 31201	09-15-86
Carlson A W, Chf Engr (Ret), WP RR, 414 Alameda De Las Pulgas, San Mateo, CA 94402	09-18-55
Carter J W, B&B Supv (Ret), Virginian RY, 1910 Maylin, Salem, VA 24153	05-01-47
Cary N M, Proc Engr Trk (Ret), Southern RY, 533 Windgrove Rd, Marietta, GA 30067	03-16-53
Chamberlain P L, Asst To Engr Strs (Ret), Erie Lackawanna RR, 26 Kathleen Pl, Morris Plains, NJ 07950	09-22-41
Chambers J W, Br Const Engr (Ret), MP RR, 12300 Eddie & Park Rd, St Louis, MO 63127	06-18-41
Christensen M C, Asst Chf Engr-Strs (Ret), C&NW RY, 401 W Crystal Ave, Lombard, IL 60148	10-07-63
Clark W H, Chf Engr-Const (Ret), AT&SF RY, 1029 Matador Dr, SE, Albuquerque, NM 87123	09-28-59
Cook, Jr. J C, Gen Frmn B&B/W&S (Ret), AT&SF RY, 3510 Gila (Western Hills), Temple, TX 76501	12-05-59
Cummings L, Gen Br Insp, SP Trans Co, 1925 Regina, Eugene, OR 97402-1107	08-12-69
Cummins C P, Br Engr (Ret), St Louis Div Of Hwys, 7934 Stanford Ave, University City, MO 63130	10-13-48
Davidson J W, Asst CE Des & Strs (Ret), BN RR, 10734 Glenwood Ave, Overland Park, KS 66211	08-26-57
Diehl C M, Reg Engr Str & Prs (Ret), Chessie System, Rt 1 Box 83, Clearville, PA 15535	08-31-59
Dixon C E, Supv B&B (Ret), Maine Central RR, 298 Fern St, Bangor, ME 04401	09-21-55
Doherty G D, Div Supv B&B (Ret), Soo Line, 2424 McKinley, Perry, IA 50220	05-08-70
Duncan F, Rdm (Ret), Winston-Salem Southbound RR, 1297 E Cannon Ave, Albermarle, NC 28001	09-09-62
Duquaine D J, B&B Supv (Ret), CMSP&P, 2365 Thompson, Kingman, AZ 86401	08-28-68
Durrant H B, Asst Chf Engr (Ret), UP RR, 3616 S 100th St, Omaha, NE 68124	09-06-68
Eichenlaub C M, Supt (Ret), San Diego & AZ East RY, 9509 Lamar St, Spring Valley, CA 92077-2810	08-23-43
Erskine J A, Strl Eng (Ret), IC RR, 1663 Hunter Ave, Mobile, AL 36604	07-22-59
Fairchild E H, Asst Engr (Ret), UP RR, 1107 Reid Ave, North Platte, NE 69101	06-30-58
Foreman J E, Dir Engrg Srvs (Ret), B&LE RR, 522 Reynolds Rd, Greenville, PA 16125	02-06-57
Forseth C E, Div Engr (Ret), WP RR, 1116 Oakmont Dr #6, Walnut Creek, CA 94595	03-31-50
Fort O E, Ch Engr (Ret), SL&SF RY, 854 S Revolta Cade Dr, Mesa, AZ 85208	02-06-57
Frame R E, Chf Engr Offr (Ret), CSX Transportation, Ocean 2100, Apt F-1, Jacksonville, FL 32250	06-22-65
Franzen E T, Ch Engr Dsgn & Cons (Ret), MP RR, 83 Webster Woods, Webster Groves, MO 63119	02-06-57
Fredrick E R, Engr B&B (Ret), FEC RY, 304 St George St, St Augustine, FL 32084	03-23-65
Gableman P D, Mgr Envrn Engr (Ret), DM&IR RY, 201 E 8th St, Superior, WI 54880	09-14-66
German J G, VP-Engrg (Ret), MP RR, 19 Holloway Dr, Lake Saint Louis, MO 63367	10-11-67
Gipson C G, Gen Frmn B&B/WS (Ret), AT&SF RY, 3955 W Cactus Wren Dr, Phoenix, AZ 85021	01-01-57
Goforth J A, Ch Engr (Ret), Clinchfield RR, PO Box 108, Erwin, TN 37650	01-01-54
Golem G G, Asst Engr-Br Dept (Ret), IC RR, 715 Vinewood, Willow Springs, IL 60480	04-27-64
Gould D C, Asst Strl Engr (Ret), UP RR, 2123 S 109th St, Omaha, NE 68144	10-10-67
Grecco E F, Proj Mgr (Ret), B&LE RR, 201 Woodbury Dr, Butler, PA 16001	01-06-69
Gunkle W J, Sr Str Insp (Ret), Conrail, 107 Fairhill Rd, Morton, PA 19070	01-10-66
Haines W W, B&B Supv (Ret), UP RR, 1911 SW 42nd St, Pendleton, OR 97801	09-27-67
Hamilton W A, Br Engr (Ret), AT&SF RY, 3007 Atwood, Topeka, KS 66614	09-13-65
Hawley I H, Ch Engr (Ret), C&IM RY, 40 Friars Lane, Springfield, IL 62704	12-02-57
Hedley W J, Asst VP (Ret), N&W RY, 824 N Biltmore Dr, Clayton, MO 63105	09-17-50
Hellweg R D, Reg Engr (Ret), Amtrak, 1301 N Eastholme, Bloomington, IL 61701	02-25-47
Hodgkins E W, Exec Dir (Ret), AREA, 238 Marquette, Park Forest, IL 60466	10-15-58
Hogel E C, B&B Supv (Ret), UP RR, 2600 West E St, North Platte, NE 69101	05-06-58
Hoppell V E, B&B Supv (Ret), UP RR, 35160 SE Skoggan Rd, Sandy, OR 97055	11-17-67
Howard J G, Gen B&B Supv (Ret), WP RR, 1624-36th St, Sacramento, CA 95816	10-05-53
Howe A K, Cvl Engr (Ret), Envirodyne Engineers, 3159 Cheryl Dr, Hendersonville, NC 28739-1115	03-08-62
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Hunter A L, Supv Strs (Ret), B&LE RR, 8 Park Ave, Greenville, PA 16125	10-05-60
Hutcheson T B, Asst VP/Ch Engr (Ret), Seaboard, 5621 Cary St Rd #4, Richmond, VA 23226	09-05-61
Hyma W R, Br Eng Sys (Ret), AT&SF RY, 18 Bertoldo Rd, Park Forest, IL 60466-1847	01-01-69
Iler F C, Gen Frmn B&B/WS (Ret), AT&SF RY, 610 Williamson Ave, Winslow, AZ 86047	12-14-65
Irby C W, Gen Frmn B&B/WS (Ret), AT&SF RY, RR 2 Box 2746, Belton, TX 76513	09-26-67
Jackman C E, Trans Cnslt (Ret), 214 W Elpin Dr, Baltimore, MD 21228	10-15-58
Jackson T E, Gen B&B Supv (Ret), SP Trans Co, 109 Karen Dr, Benicia, CA 94510	01-01-40
Jenkins H W, Ch Engr (Ret), NYNH&H RR, PO Box 447, Green Valley, AZ 85614	01-13-40
Johnson E A, Eng Br (Ret), IC RR, 17720 Dixie Hwy, Homewood, IL 60430	01-01-53
Johnson H T, Matl & Equip Engr (Ret), Penn Central, 52 Helena St, E Brunswick, NJ 08816	10-05-60
Kendall J T, Supv Strs (Ret), Penn Central, 312 Cypress St, Montoursville, PA 17754	07-15-49
King L E, Reg B&B Mgr (Ret), SP Trans Co, 4100 Spring Valley Rd, Rocklin, CA 95677-1537	06-14-66
Langham L D, Div Engr (Ret), AT&SF RY, Rt 1 Box 110-A, De Kalb, TX 75559	12-08-64
Laurick M J, Proj Engr (Ret), Conrail, 1693 Sandalwood Pl, Columbus, OH 43229	12-08-52
Lawton R R, Asst Chf Eng Stf (Ret), C&NW Trans Co, 1334 Naperville Rd, Wheaton, IL 60187	09-13-65
Layer J P, Sr Engr (Ret), R W Consultants Inc, 5743 Lynn Dr, Franklin, OH 45005-5111	09-02-66
Leach L J, B&B Supv (Ret), UP RR, 502 Gypsum, Blue Rapids, KS 66411	09-26-67
Lelevich L E, Mgr Bdgts (Ret), UP RR, 7401 Alix Pkwy, Sacramento, CA 95823-3003	02-09-67
Linn G A, Div Engr (Ret), C&NW Trans Co, PO Box 141, Thedford, NE 69166-0141	10-07-40
Long W R, Mtl Plnr (Ret), SP Trans Co, 2320 S Jackson St, Albany, OR 97321	12-09-63
Lowry J M, Asst Dist Engr (Ret), SP Trans Co, 5242 Jackwood St, Houston, TX 77096	05-03-50
Lund C V, Asst To VP/CE (Ret), CMSP&P, 344 Scott Ave, Glen Ellyn, IL 60137	02-25-47
Mabry D B, VP-Sales (Ret), Moss-American Inc, 420 Edgewood Dr, St Louis, MO 63105	10-13-48
Martin J W, Mast Carp (Ret), Seaboard, 4656 E Glen Ridge Crcl, Winston, GA 30187	09-14-53
Martyn G W, Mgr Fac & Cvl Eng (Ret), EJ&E RY, 510 Peale St, Joliet, IL 60433	07-22-59
Mathias H O, Mgr Cntrs & Admn (Ret), IHB RR, 320 S 8th Ave, LaGrange, IL 60525	09-28-59
McCoy D E, B&B Supv (Ret), BN RR, 8378 Cherokee, Denver, CO 80221	03-23-65
McMaster R C, Mgr Fac & Strs (Ret), B&LE RR, 318 Clinton St, Greenville, PA 16125	01-10-66
Messman D V, Asst To CE (Ret), Southern RY, 3329 Stonecrest Ct, Atlanta, GA 30341	03-14-55
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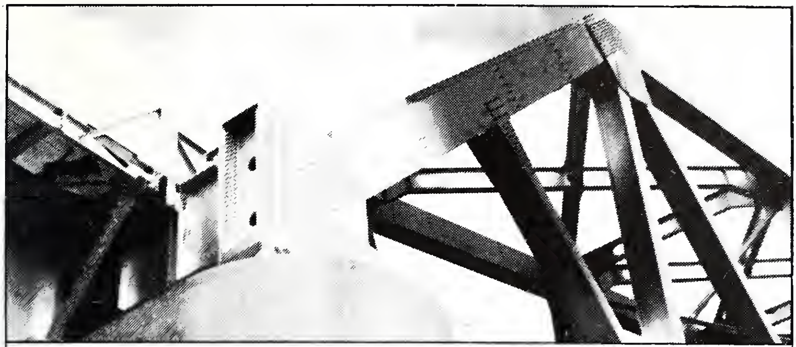

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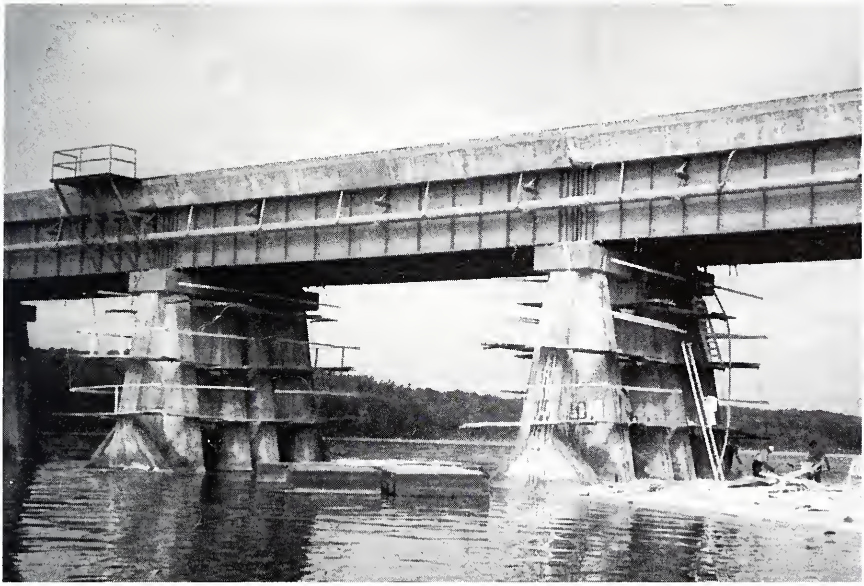

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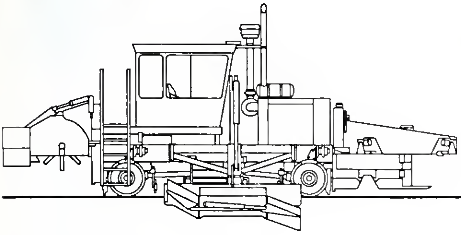

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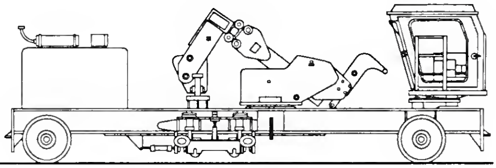

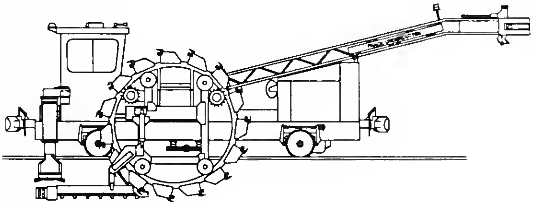

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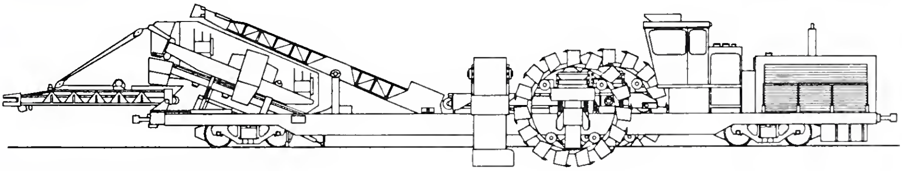

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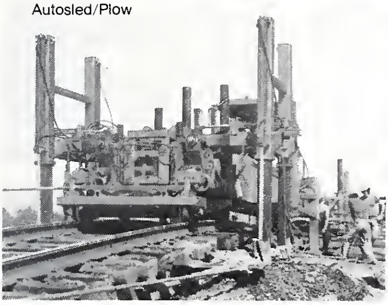

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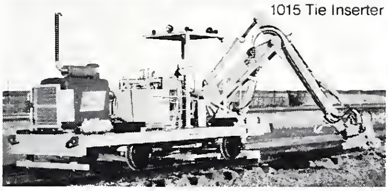

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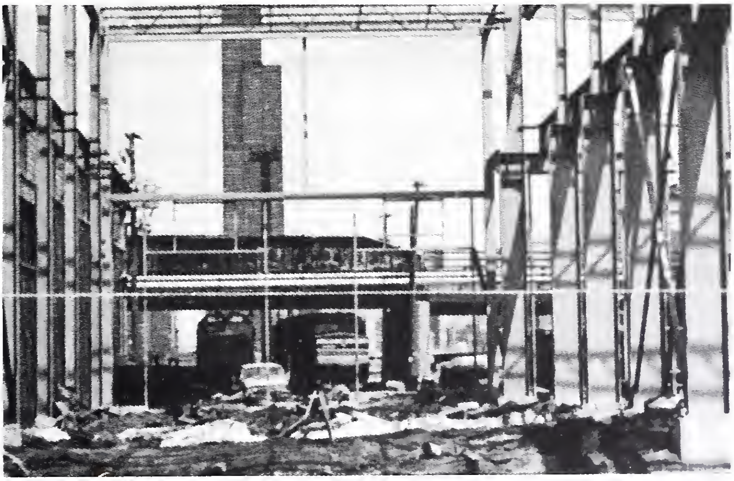

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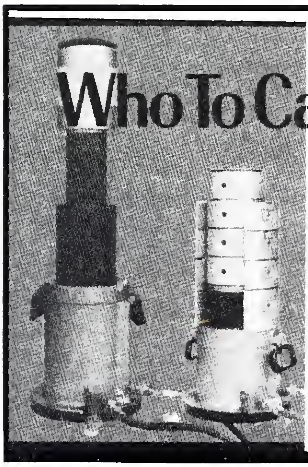

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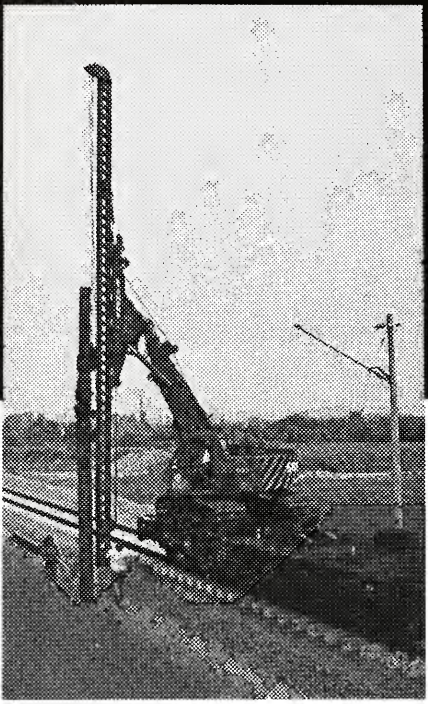

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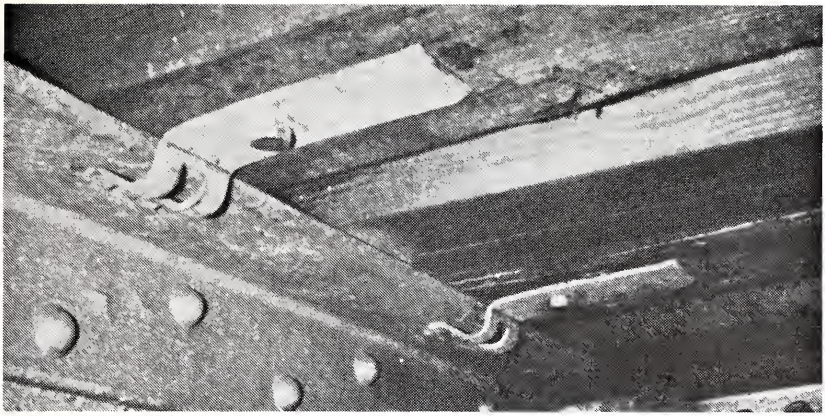

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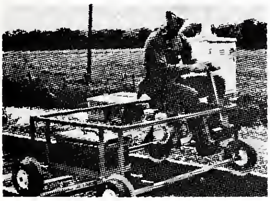

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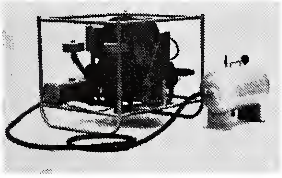

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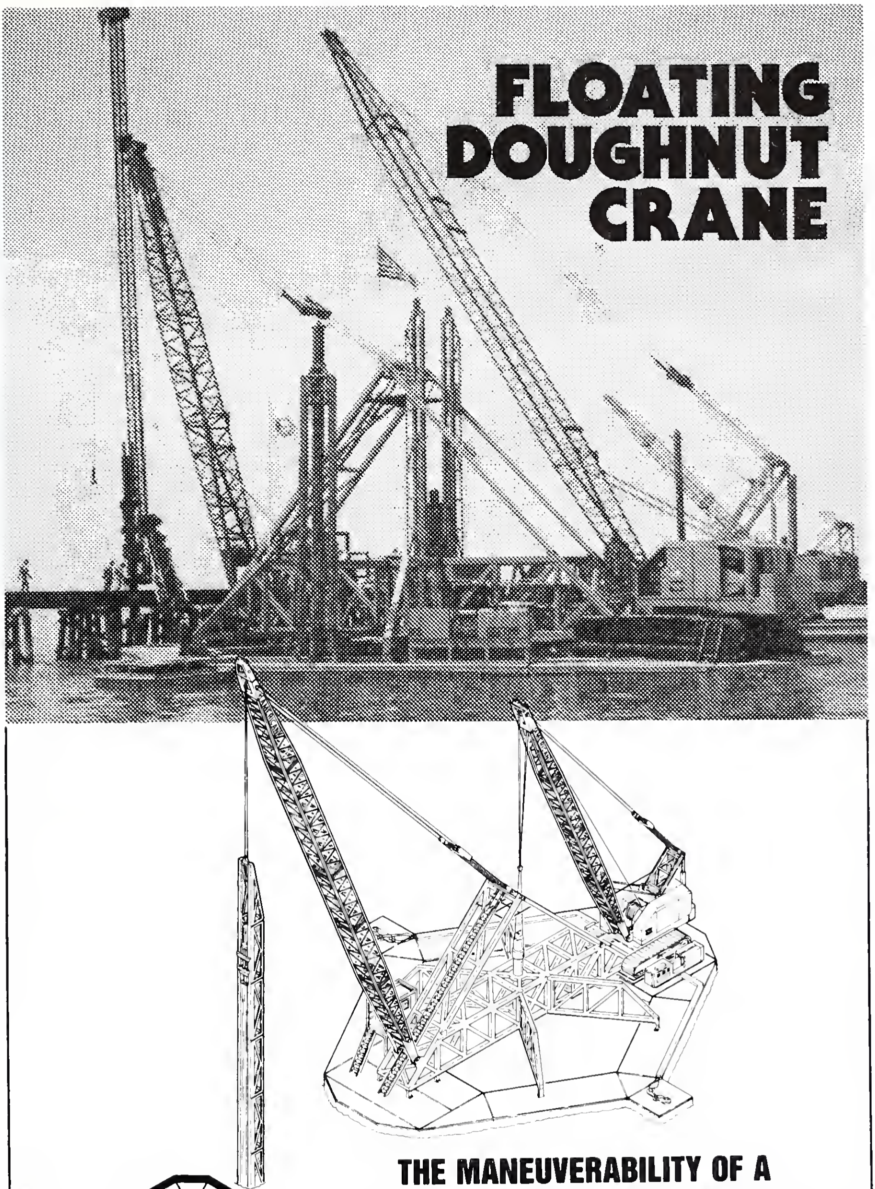

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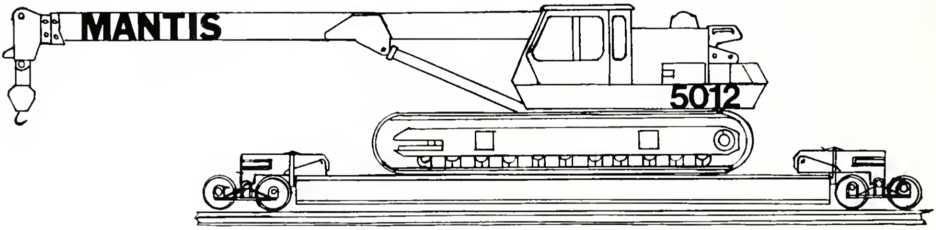

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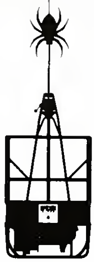

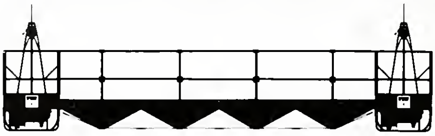

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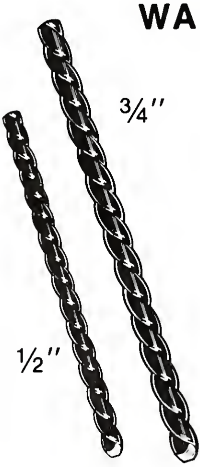

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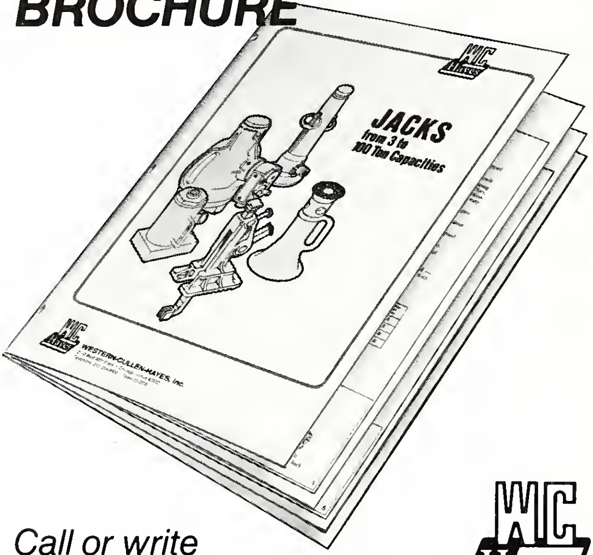

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1978-1987

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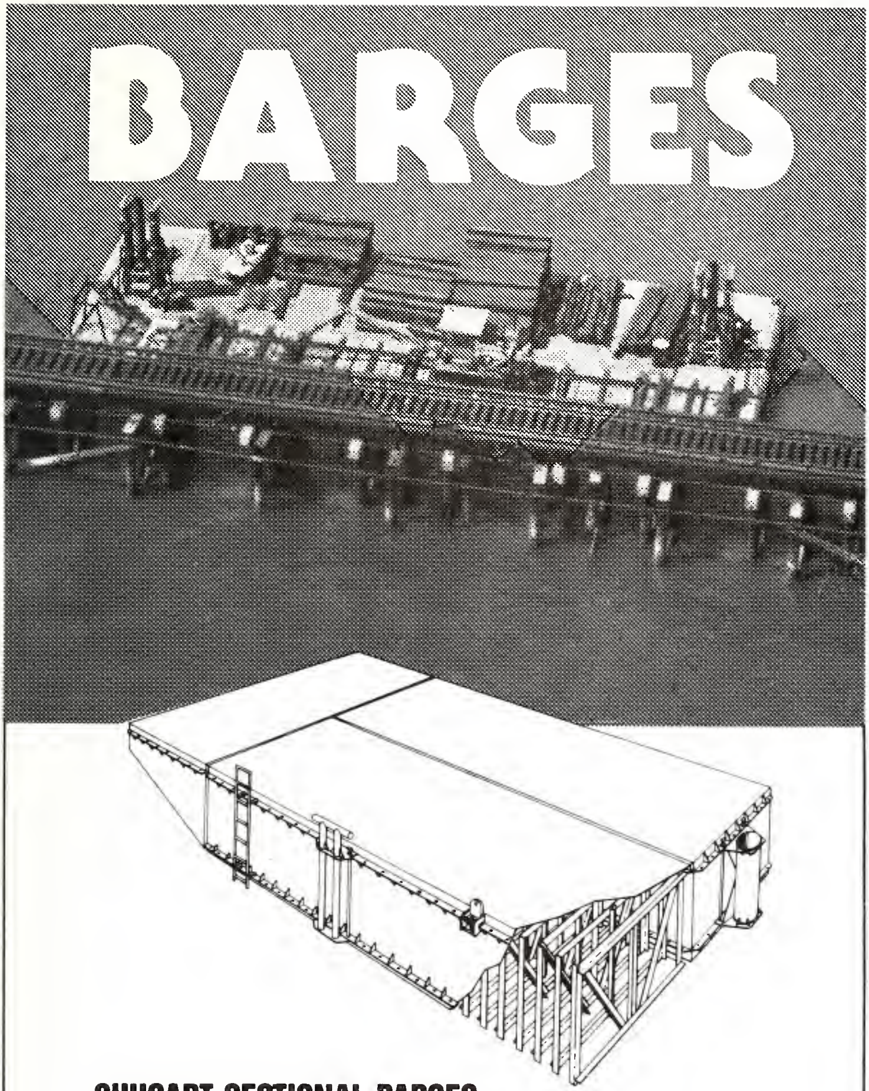

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